ACADEMIC PROCEEDINGS - 18TH BIENNIAL CONGRESS OF THE SOUTH AFRICAN SOCIETY OF NUCLEAR MEDICINE (SASNM) 10TH – 12TH AUGUST 2018

Friday 10 August, 2018

Breast Imaging

Session 1: 08h20: Chairpersons: J Buscombe/W Pilloy

Molecular Imaging with High Resolution Breast Positron Emission Tomography: Use in Different Clinical Scenarios

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Several imaging modalities have been introduced in recent years to improve screening and staging of breast cancer. High Resolution Breast PET Imaging (BPI) has been approved some years ago and introduced into clinical use as complementary diagnostic to mammography and breast ultrasonography/MR. BPI has higher resolution and a more localized field of view than positron emission tomography–computed tomography (PET-CT) and can be performed on patients to stage a newly diagnosed malignancy but, more importantly, to evaluate therapy response in locally advanced breast cancer and in pre-surgical planning. Review of mammograms together with magnetic resonance or Breast PET images improves detection/recurrence of disease. The best way to evaluate and read a BPI study is based on modelling (morphology) and semi-quantitative FDG uptake.

The Role of ^{99m}Tc-Mibi Scintimammography in Predicting Malignancy in Patients Suspected to have Fibroadenomas of the Breast on Mammography

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Background: Breast cancer is the commonest cause of cancer in women worldwide and the most frequent cause of cancer death in women in developing countries. There is a rising incidence in South Africa, particularly in young women. Coincidentally, young women also have a high incidence of benign breast lesions, fibroadenoma being the commonest. Mammography is the screening tool of choice for evaluating suspicious breast lesions but is limited by its low sensitivity in women with dense breasts. Thus, many biopsies are performed for benign lesions – this overwhelms the pathology service. **Aim:** To determine whether semi-quantitative evaluation using ^{99m}Tc MIBI scintimammography may be complementary to mammography and breast ultrasound in fibroadenomas and guide selective biopsy. **Methods:** Sixty nine (69) lesions diagnosed as breast fibroadenomas on ultrasonographic and/or mammography examination were subsequently evaluated with ^{99m}Tc-MIBI scintimammography qualitatively and semi-quantitatively. Histopathological examination of biopsied lesions was used as the "gold standard" for the detection of malignancy. **Results:** Forty (40) patients contributed 69 lesions for the study. Their ages ranged between 14 and 71 years (mean 33 years). 80% of the patients were below the age of 50 years. 15 (22%) lesions were malignant and 54 (78%) were benign on histopathological examination. Qualitative scintimammography had sensitivity of 80%, specificity 69%, PPV 41%, NPV 93% and accuracy 71% for detecting breast malignancy. The semi-quantitative uptake ratio (L: B) was in the 2,08 – 8,27 range for malignant lesions and 0 – 5,57 for benign lesions. A L: B uptake ratio of 2,1 or more was interpreted as positive and yielded sensitivity of 100%, specificity of 74%, PPV of 50%, NPV of 100% and accuracy of 78% for detection of malignancy. The washout ratio (WR) ranged from 0,08 to 0,78 for malignant lesions and 0,24 to 1 for benign lesions. A WR of 0,5 or less was interpreted as positive for malignancy and yielded sensitivity of 73%, specificity of 80%, PPV of 48%, NPV of 90% and accuracy of 78%. **Conclusion:** The addition of semi-quantitative parameters to qualitative assessment resulted in improved sensitivities of 100% and 80%, with corresponding specificities of 87% vs 72% and NPV 100% vs 93% for patients presenting with fibroadenoma. The high NPV obtained when using the L: B uptake ratio suggests that scintimammography can aid in excluding malignancy, thus obviating the need to conduct breast biopsy. This could eliminate patient anxiety and further decrease the workload of the pathologist and cost related to biopsy.

^{18}F-FDG PET/CT Whole Body Scan versus Conventional Imaging in the Staging of Breast Cancer at DGMAH

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Background: Worldwide, breast cancer (BC) is the most frequently diagnosed life-threatening cancer in women. While survival rates in developed countries have improved

(mainly due to early detection via screening programmes and patient education), BC remains a leading cause of death in developing countries, attributable to more advanced presentation at initial diagnosis. In South Africa, BC is the most common cancer in females, accounting for 20.62 % of all malignancies. Accurate staging of BC is essential as it guides management and determines prognosis. Conventional imaging (CI) for staging of Breast Cancer involves a multimodality approach – chest x-ray (CXR), bone scintigraphy (BS) and ultrasound (US) of the axillae and abdomen. This retrospective study aimed to compare the diagnostic accuracy of a single-step whole body (WB) ^{18}F-FDG PET/CT with CI. **Methods:** 53 patients with biopsy proven primary Breast Cancer (52 females and 1 male with a mean age of 53 ± 15 years) underwent pre-treatment whole body ^{18}F-FDG PET/CT and CI. Histopathology, complementary/repeat imaging and/or clinical follow-up served as standards of reference. **Results:** WB ^{18}F-FDG PET/CT was more accurate than CI in the detection of extra-axillary nodal and distant metastases ($p<0.001$). The sensitivities and specificities of FDG PET/CT versus CI modalities were as follows: 1. Extra-axillary nodal disease 83% and 98% versus 50% and 95% for US; 2. Bone metastases 88% and 97% versus 80% and 87% for BS; 3. Liver metastases 90% and 100% versus 60% and 95% for US and 4. Lung metastases 100% and 98% versus 60% and 98% for CXR. WB ^{18}F-FDG PET/CT detected additional previously unknown sites of disease in 43% (23/53); and changed management in 19% (10/53) of patients. **Conclusion:** WB ^{18}F-FDG PET/CT was more accurate than CI in the detection of extra axillary nodal and distant metastatic disease, although the study had limitations including a retrospective design and possible selection bias.

Cardiology

Session 2: 09h30: Chairpersons: O Gheysens/N Malan
Choosing the Right Stressor for Myocardial Perfusion Imaging: The Role of Pharmacologic Stressor Agents

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Exercise stress is preferred when used in conjunction with single photon tomographic myocardial perfusion imaging (MPI) since it provides the prognostic variables of exercise capacity, patient symptoms, electrocardiographic ischemia and heart rate recovery. Unfortunately >50% of patients cannot perform a maximal exercise effort due to non-cardiac limitations. Furthermore, pharmacologic stress is required with positron emission tomographic MPI due to the short half-life of the radiotracers. Pharmacologic stressors include dipyridamole (DIP), adenosine (ADEN), regadenoson (REG) and dobutamine (DOB). All but DOB are pharmacologic vasodilators which activate ADEN A2A receptors to induce arteriolar vasodilation. REG is a semi-selective A2A agonist whereas the others activate all ADEN receptors which may result in bronchospasm or heart block. DIP has the longest half-life, followed by REG (several minutes) and ADEN (several seconds). DIP and ADEN have similar diagnostic accuracy as compared to exercise MPI. REG has similar diagnostic accuracy to ADEN stress and induces ischemic perfusion defects of similar size. All are reversed by aminophylline which competes for ADEN receptors. Unlike ADEN and DIP, REG can be used safely in patients with moderate to severe chronic obstructive lung disease or mild to moderate asthma. The diagnostic accuracy of all pharmacologic vasodilators is variably affected by caffeine intake. All agents can be used in patients with left bundle branch block. DIP and ADEN are safe in patients with acute coronary syndromes whereas no data currently exist for REG in this population. Radiotracers are injected within 30 seconds of REG bolus administration, 3-5 minutes after a 4 –minute DIP infusion, and 2-minutes into a 4-minute ADEN infusion. REG can be safely administered on the treadmill in patients who attempt exercise stress but only perform a submaximal effort. Due to its relative selectivity, lower side effect profile, ease of administration and diagnostic comparability, REG has become the preferred pharmacologic stressor agent.

Imaging Cardiac Sympathetic Innervation: Current Clinical Status

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Although imaging of cardiac innervation has a long history for both SPECT and PET tracers, starting with the use of ^{123}Iodine-*meta*iodobenzylguanidine (^{123}I-*m*IBG) and up to the development of N-[3-bromo-4-(3-^{18}F-fluoro-propoxy)-benzyl]-guanidine (^{18}F-LMI1195), widespread clinical use has not been accomplished. Nonetheless, imaging cardiac innervation has some very interesting applications and can, when properly used, add valuable information in the process of clinical decision making. Cardiac innervation can be divided into the two counteracting autonomic systems, the sympathetic and parasympathetic system. For both systems radiotracers have been developed, but experience with the parasympathetic pathway is very scarce and is still far away from clinical implementation. The sympathetic system can be further divided into a presynaptic and postsynaptic part. The postsynaptic part, in which the main imaging target is the β-adrenergic receptor, has been

studied with some very specific tracers, such as ^{11}Carbon-CGP-12177, but due to problems regarding synthesis and availability, clinical use is severely hindered. Other postsynaptic tracers neither have proven their clinical value yet. On the opposite, experience with presynaptic cardiac imaging is extensive. Most of the used tracers are designed as analogues of norepinephrine (NE) and are taken up, concentrated and stored in the presynaptic nerve terminals. Among these tracers are SPECT-based ^{123}I-*m*IBG, but also newer PET-based carbon-11 labelled *meta*hydroxyephinephrine (^{11}C-*m*HED) and ^{18}F-LMI1195. The latter has been developed to function as ^{123}I-*m*IBG, exploiting the experience with the SPECT tracer, but harvesting the advantages of PET imaging in spatial resolution and quantitative analysis. The most commonly used semi-quantitative measurements of myocardial ^{123}I-*m*IBG uptake are the early heart-to-mediastinum (H/M) ratio, derived 15 min post injection (p. i.) of ^{123}I-mIBG, late H/M ratio, derived 4 h p. i. and the ^{123}I-*m*IBG washout (WO), calculated as the difference between early and late H/M ratio and expressed as a percentage of the early H/M ratio. These tracers enable the assessment of several clinical problems, including chronic heart failure, cardiac arrhythmia, cardiotoxicity due to cancer treatment, and cardiac amyloidosis. During this presentation an overview of the current clinical status of cardiac innervation imaging will be provided.

Machine Learning for Risk Assessment in Cardiac Imaging

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Machine learning (ML) has been increasingly utilized within the domain of cardiac imaging research, for image analysis, diagnosis and risk assessment. ML is able to integrate multiple pieces of information including clinical and imaging data in quantitative fashion into a probabilistic score for a given outcome. Recent advances include deep learning techniques which can learn directly from image data. ML results for prediction of obstructive disease, revascularization, death or major adverse cardiac events have been reported using CT, SPECT and PET data, surpassing in accuracy currently used risk scores. However, barriers still exist for ML to be used in routine clinical practice.

Arterial Inflammation Demonstrated on F-18 FDG PET/CT Imaging in Young HIV-Infected Individuals with Otherwise Low Risk for Cardiovascular Disease

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Background: Human Immunodeficiency Virus (HIV) infection is associated with increased risk of atherosclerosis at a younger age. This increased risk is attributable to the HIV virus and its treatment. Arterial inflammation is an early process that occurs before frank atheromatous lesion develops. The level of arterial inflammation predicts future risk of cardiovascular disease (CVD). F-18 fluorodeoxyglucose (FDG) uptake in the vessel wall correlates well with the level of arterial inflammation. **Aim:** Using arterial FDG uptake as a surrogate for arterial inflammation, we compared arterial inflammation in HIV-infected and HIV-uninfected patients with otherwise low-risk factors for CVD. **Methods:** A total of 306 patients aged 18 to 40 years with no or low-risk factors for CVD consisting of 153 HIV-infected patients and 153 HIV-uninfected age and gender-matched controls were studied, mean age = 32.49 ± 6.24 years. The mean of multiple SUVmax measurements taken at the level of the ascending aorta (target) was divided by the mean of multiple SUVmean measurements taken in the superior vena cava (background) to obtain a target-to-background ratio (TBR) which was used as marker of arterial inflammation. We compared the TBR of HIV-infected individuals with the non-infected controls. We determined serum levels of C-reactive protein (CRP) and determine its correlation with TBR. We also determine the correlation between gender, CD 4 count, viral load, presence or absence of HIV viremia, use of anti-retroviral therapy and the duration of HIV infection on the arterial TBR. **Results:** Median CD4 count and viral load were 384 cells/mm^3 (Range: 2-1094) and 4376.00 copies/mL (Range: 7 – 1,348,622) respectively. TBR of HIV-infected individuals was significantly higher compared with non-infected controls ($p<0.001$). TBR was not affected by CD4 count or detectable viremia. No significant difference in TBR between males and female patients with HIV infection. We found a weak positive correlation between TBR and CD4 count (r=0.113), TBR and duration of HIV infection (r=0.088) and a very weak negative correlation between TBR and viral load (r=-138). There was no significant difference in TBR between patients on anti-retroviral therapy and those not yet on it. CRP was significantly higher in the HIV-infected group compared with controls (p=0.033). **Conclusion:** Higher TBR and serum levels CRP demonstrated in HIV-infected individuals suggest arterial inflammation in these young patients with low risk factors for CVD. In our cohorts, arterial inflammation is not affected by

gender, CD4 count, presence or absence of detectable viremia and anti-retroviral therapy use.

Oncology/Endocrinology/ Orthopaedics

Session 3: 13h00: Chairpersons: E Garin/M Sathekge

Metomidate in Adrenocortical Tumours

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Conn's tumours were thought of a rare (<1%) cause for hypertension but one that was worth finding as removal of the Conn's tumour could be considered curative. For many years Conn's tumours could be confirmed by the use of Se-75 cholesterol imaging with images at baseline, 1 week and 2 weeks. This could find Conn's tumours sized about 20 mm and above.

Then along came CT and MR when small 5-6mm adrenal nodules can be seen, but such nodules are common and hypertension is common. New assays for adrenocorticoids started to show many patients having a raised adrenocorticoid level but this may be due to Conn's tumours or other causes such as anxiety.

A more specific method was needed and the University of Uppsalla was able to label a drug, metomidate, which has preferential uptake in the Conn's tumours with C-11. Its use was limited by non-specific uptake in the normal adrenal so masking small Conn's tumours. It was then found possible to suppress this physiological uptake with hydrocortisone given in the 48 hours before the scan so that only the autonomous Conn's tumours now has uptake. Using the latest in time of flight PET imaging and by pre-treating with 48 hours of hydrocortisone we can now find tumours as small as 5mm using 200 MBq C-11 metomidate. Uptake in the tumour is measured and needs to be 1.4x the normal ipsilateral or contralateral adrenal. Using this we can find Conn's tumours in 90% of patients suspected of having the disease by biochemical means. Also precise localistaion has led to adrenal saving surgery allowing on the tumour to be removed and leaving the normal adrenal hence preventing the patient becoming addisonian.

C-11 metomidate has shown small adrenal Conn's tumours can be localised, now a version labelled with F-18 or I-124 needs to be developed to allow more centres to use this technique.

Radioactive Iodine Treatment for Differentiated Thyroid Carcinoma 2018 Perspective

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- History of Radioactive Iodine Therapy
- Treatment options for Differentiated Thyroid Cancer
  a) Based on Target Tissue definition
  b) Based on Activity Selection approach.
- How to determine the best-administered dose activity
- What is a logical and acceptable practice in 2018
- Available evidence for such a practice
- How to identify "fake news."

Management of Differentiated Thyroid Cancer – Beyond the 2015 American Thyroid Association Guidelines

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Although a rare malignancy with good prognosis, differentiated thyroid cancer (DTC) has shown a rise in incidence in recent decades. While it is advised to manage patients in a multidisciplinary (MDT) way, different guidelines from many professional bodies do not always offer full consensus.

The latest published guidelines of the American Thyroid Association (ATA 2015), and probably the leading professional body in the understanding and management of thyroid cancer, prompted some reactions in terms of their endorsement.

In order to harmonise views on the management of DTC, several representatives of the main professional bodies met early this year to address controversies linked to the use of radioactive iodine in DTC.

In this presentation, we will use practical cases to provide tools for those who find themselves outside of a MDT facility on how to approach real life scenarios and think critically about management decisions for DTC.

The Reliability of Estimated Glomerular Filtration Rate in South African Children

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Background: Glomerular filtration rate (GFR) is widely accepted as the best measure of kidney function. It is integral to the management of children with chronic kidney disease and those receiving nephrotoxic drugs

chronically, yet a paediatric service is offered by only a few academic hospitals in South Africa. In most instances, GFR is simply estimated from the serum creatinine concentration using an empiric equation. The Schwartz formula is most commonly used, while the Flander's metadata equation, Gao's quadratic equation, and the FAS equation have been published more recently. These equations were all developed in predominantly Caucasian paediatric populations in North America and Europe and to date the equations have not been validated in African children. It is hypothesized that, due to differences in pathology and socioeconomic conditions, serum creatinine levels will be lower on average leading to higher GFR estimates. **Aim:** To determine the reliability of estimated GFR in South African children. **Methods:** Cross-sectional study of children referred for GFR measurement at the Red Cross Children's Hospital, Cape Town. Between February 2014 and August 2015 children were included if serum creatinine had been measured on the day of the GFR study (retrospective group). From September 2015 to November 2017 (prospective group), a blood sample was taken for creatinine measurement at the start of the GFR study. In all children GFR was measured (mGFR) from the plasma clearance of Cr-51 EDTA. Venous blood samples were taken at 2h and 4h. Clearance was calculated using the slope-intercept method, corrected for BSA, and the Jodal Brochner Mortensen equation was applied. GFR was estimated (eGFR) using the new bedside Schwartz formula, the Flander's metadata equation, Gao's quadratic equation, and the FAS equation. The bias, precision and accuracy of each equation was determined, and Bland-Altman analyses were performed. **Results:** 173 children were included (100 female; median age 9 years; median GFR 91.5 ml/min/1.73m^2). The correlation between eGFR and mGFR was poor with r^2 = 0.40-0.45. All equations over-estimated GFR with median biases of 16.0-26.8 ml/min/1.73m^2. The precision was also poor with RMSE values of 14.8-34.8 ml/min/1.73m^2. The accuracy, expressed as the percentage of estimated GFR values within 30% of mGFR (P_{30}), was 43-63%. **Conclusion:** The accuracy of eGFR in South African paediatric patients is extremely poor and it cannot replace mGFR. There is a need for development of an estimating equation from local data, as well as increased availability of GFR measurement.

^{99}mTc-MDP Bone SPECT-CT in Postoperative Spine

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Back pain is common and diagnosis and treatment varies depending on the clinical presentation. Imaging of patients with back pain pre and post-operative scenarios include radiological and radionuclide techniques is often guided by clinical question. Imaging techniques have their own advantages and limitations. The aim of surgery is to eliminate pathological segmental motion and accompanying symptoms. However, they are not without complications and localizing the cause of the pain is often challenging. 99mTc-MDP Bone SPECT/CT is reported to be useful and often provides valuable information such as accurate localization and characterization of bone abnormalities and might localize potential pain generators. In this presentation, I would like to discuss spinal surgical techniques/procedures, acute and delayed complications, and potential uses of 99mTc-MDP Bone SPECT/CT.

Oncology/Therapy

Session 4: 15h45: Chairpersons: R Baum/N Nyakale

Characterization of Tumors and Molecular Imaging in Theranostics

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Next to the most common indications for imaging (staging and restaging), molecular imaging offers unique opportunities for characterization of tumors. This offers opportunities to identify the most aggressive parts of heterogenic tumors for biopsies, while excluding non-viable tumor lesions. This is one of the classic indications for FDG-PET/CT beyond staging of disease. As it is not possible in widespread metastatic disease to characterize disease with a large number of biopsies, molecular imaging offers the opportunity not only to identify those patients in whom tumors lack the therapeutic target, but also to address intrapatient heterogeneity of tumor features which may heavily impact on treatment selection. This exemplified by the use of Zr-89 or I-124 labeled monoclonal antibodies for immunoPET. In immunoPET, detection of additional lesions is secondary to actual identification of variability in target expression. Thus, for this indication, molecular imaging can serve as whole body in-vivo immunohistochemistry to underpin the individual patient's eligibility for targeted treatment. In a subset of patients, molecular imaging findings direct the use of radiolabeled therapeutic agents in a so-called theranostic approach. With an increasing number of therapeutic radiolabeled pharmaceuticals becoming available for clinical research and patient treatment, theranostics will become more important to select and

re-assess therapeutic response in cancer patients. With Ga-68/Lu-177-DotaTate and Ga-68/F-18/Lu-177/Ac-225-PSMA as role models this approach may become an important area of growth for nuclear medicine.

MAA Dosimetry and Intensification with Selective Internal Radiation Therapy in HCC

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Selective Internal Radiation Therapy (SIRT) using ^{90}Y loaded microspheres is used from many years for the treatment of non-operable HCC with interesting clinical results despite the negativity of recent phase 3 studies with no specific dosimetric end point. Indeed with glass microspheres the activity to inject is classically calculated to deliver between 80 to 150 to the liver, and with resin microspheres it is based on the BSA.

New developments using predictive dosimetry based on MAA quantification have demonstrated a clear dose response relationship and significant impact of the tumor dose on overall survival with a threshold dose depending on the product used, glass or resin microspheres. The difference of the threshold observe between both product is recognized to be in relation with a difference in the heterogeneity of the dose distribution with both product with 50 fold more spheres injected for the same activity with resin microspheres.

Specific technical endpoints regarding MAA dosimetry and main results are presented.

Regarding technical endpoints it has to be highlighted that the use of MAA for a full quantification and dosimetry, by opposition to a simple lung shunt evaluation, requires several recommendations as a rigorous catheter repositioning between the MAA simulation and the treatment itself, a blood flow preservation (limitation of spasm occurrence) and slow MAA infusion.

About dosimetry results glass microsphere the threshold tumoral threshold dose recognized is 205 Gy with a probability of response of 91% if the dose is higher than the threshold and of only 6% if it is below the threshold. The relative risk of death for the patients with a low dose is 2.35 ($p=0.0053$) for the global population and is even higher, 6.9 ($p= 0.0025$), for PVT patients. With resin microsphere the threshold dose identified is between 100-120 Gy with, in the randomized phase III SARAH, a disease control rate of 65% if the dose is higher than the threshold and of only 34% if it is below the threshold and with a relative risk of death of 2.7 for the patients with a low tumor dose ($p<10^{-3}$).

According to those results treatment personalization and intensification approaches have been describe, based on the 205 Gy threshold dose to reach for glass microsphere and on the 120 Gy threshold dose to reach with resin microspheres. The impact of treatment personalization has been described to be of high interest in retrospective studies for PVT patients with median overall survival reaching more than 20 months.

MAA based personalized dosimetry is more than likely a major way of improvement of the effectiveness of SIRT and has to be implemented in prospective trials as the lack of dosimetry in the actual phase 3 study is probably, at least partially, responsible of the negativity of those trials.

Radium-223: The Guildford Experience after Four Years in Clinical Practice

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[1]Department of Nuclear Medicine, Royal Surrey County Hospital, Guildford, Surrey, UK

Background: Results from the ALSYMPCA study in 2013 showed improved survival in patients with castration-resistant prostate cancer after Ra-223 treatment, leading to FDA and EU approval. After participating in the Alpharadin and ALSYMPCA trials, our institution applied the treatment according to the UK's funding criteria, which require selected patients to have symptomatic bone metastases without visceral involvement, after previous docetaxel treatment. Our clinical protocol initially followed the ALSYMPCA pathway, but has since been refined and optimised. **Aim:** To optimise the patient pathway for Ra-223 treatment, and to compare our real-world outcomes to the clinical trial results. **Methods:** Patient survival was investigated in 106 patients using Kaplan-Meier analysis, and the median overall survival was compared to that of ALSYMPCA. The blood markers PSA and ALP were recorded over the course of treatment, allowing trend analysis. The complex patient pathway was significantly streamlined after consultation with oncologists and other stakeholders. **Results:** Median overall survival in our patient population was 12.1 (95% C. I. 9.5 to 18.4) months, which is similar to that reported by ALSYMPCA (14.9 months). Average blood marker trends showed that PSA tends to rise during treatment, whereas ALP decreases, with a nadir typically at Cycle 4. 10 patients died before completing the full course of Ra-223 treatment, highlighting the importance of placing this therapy early in the treatment pathway. Our improved patient pathway has resulted in positive feedback from both patients and referrers. **Conclusion:** Patient survival in our practice was found to be in line with previously published ALSYMPCA results. Careful patient selection is required in order to ensure the best outcomes. There was a learning curve to smooth implication of this treatment as a routine service in the department.

F-18 Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography for Risk Assessment and Therapy Response Evaluation in Patients with HIV-Associated Hodgkin Lymphoma Compared with HIV-Uninfected Individuals

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Background: Hodgkin lymphoma (HD) is a non-acquired immunodeficiency syndrome-defining malignancy. Patients with Human Immunodeficiency Virus (HIV) infection are at increased risk of HD compared with non-infected individuals. F-18 fluorodeoxyglucose positron emission tomography/computed tomography (FDG PET/CT) imaging is the standard imaging modality for staging and therapy response assessment in HD. FDG PET metabolic metrics including standardized uptake value (SUVmax), metabolic tumor volume (MTV) and total lesion glycolysis (TLG) have shown prognostic utility in different malignancies. **Aims:** To evaluate the impact of HIV infection on (1) tumor burden using FDG metabolic metrics as surrogate for high risk indicators and (2) therapy outcome after standard regimen of adriamycin, bleomycin, vinblastine and dacarbazine (ABVD) in patients with HD. **Methods:** A total of 136 patients with classical Hodgkin lymphoma were studied, mean age ± SD =32.31±1.39 years, male=86, female=50. HIV infection was present in 57 patients while 79 patients were HIV-negative. SUVmax, MTV and TLG were obtained on FDG PET/CT done for initial staging. All patients completed standard regimen of ABVD. After a median period of 8 weeks, a repeat FDG PET/CT scan was obtained to evaluate response to therapy using the Deauville 5-point scoring system. FDG PET metabolic metrics and Ann Arbor stage were compared between HIV-infected and uninfected patients. Binary regression and multiple regression analyses were used to test for factors predictive of treatment outcome. **Results:** The HIV-positive and HIV-negative groups were similar with regards to age and Ann Arbor stage. The SUVmax, MTV and TLG of lesions were not significant different between the two groups (p>0.05). Presence of HIV infection was associated with higher rate of treatment failure (40.4% in the HIV-positive patients versus 17.7% in the HIV-negative patients, p=0.0034). HIV infection was a significant predictor of poor response to chemotherapy, p<0.001. Effects of SUVmax, MTV, TLG and Ann Arbor stage of the disease were not statistically significant as predictors of therapy outcome. In a multiple logistic regression, presence HIV infection still remained an independent predictor of therapy outcome in the presence of other factors such as SUVmax, MTV, TLG and the Ann Arbor stage of the disease [OR=2.930, 95% Confidence Interval of 1.197 – 7.172, p=0.023]. **Conclusions:** HIV-infected patients are diagnosed at similar age and disease stage compared with HIV-uninfected individuals. FDG PET metabolic metrics are similar in both HIV-infected and uninfected patients. HIV infection appears to be associated with poorer treatment outcome in HD patients treated with standard regimen of ABVD.

World Federation of Nuclear Medicine and Biology

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Saturday 11th August, 2018 Track A Cardiology

Session 5: 08h00: Chairpersons: C Libhaber/T Kotze

Assessing the Functional and Prognostic Significance or Coronary Artery Stenosis: Fractional Flow Reserve, Single Photon Tomographic and Positron Emission Tomography

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Many decades ago, stress single photon tomographic (SPECT) myocardial perfusion imaging (MPI) was shown to predict patient outcome based on the presence and extent of stress-induced ischemia with a very low reported annual death/myocardial infarction event rate of 0.5% if the study was normal vs. 6% if abnormal. Risk prediction was improved with the addition of LVEF assessed by gated SPECT. Both SPECT and positron emission tomography (PET) detect abnormalities in coronary flow reserve (CFR) which is a function of both epicardial and microvascular blood flow. SPECT identifies relative differences in perfusion within coronary vascular territories whereas

PET assesses relative and absolute differences in resting and hyperemic flows in individual vascular beds and therefore can identify specific microvascular abnormalities. This is particularly important in patients with significant multi-vessel coronary artery disease where relative perfusion may appear normal due to "balanced ischemia". Furthermore, abnormal CFR is frequently seen in women and diabetic patients with otherwise normal perfusion images and this may better predict patient outcome and guide coronary interventions. Conversely, fractional flow reserve (FFR) performed during invasive coronary angiography only assesses the functional significance of epicardial stenosis and therefore FFR and CFR results may differ regarding the angiographic significance of a specific coronary stenosis. None-the-less several studies from the FAME investigators have shown that invasive FFR measurements can guide whether patients benefit from percutaneous coronary interventions. Recently, the feasibility of performing FFR derived measurements from non-invasive CT coronary angiography studies may offer assessment of anatomy and physiology during one simple 10 second test. It remains to be seen which patients might benefit most from which testing strategy.

Coronary Plaque Quantification: CT Angio and PET

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In the past decade evaluation of coronary artery disease by visual assessment coronary CT angiography have been shown to be predictive of patient risk and to better guide patient management decisions than standard clinical data. Recently quantitative methods for single plaque evaluation characterizing both anatomical and biological features in a given lesion have emerged. It was shown that quantitative measures of plaque volume by CT coronary angiography improve the prediction of invasive fractional flow reserve measurements and cardiac death. There is therefore growing interest in developing and implementing automated methods for plaque quantification. Increased coronary artery uptake of ^{18}F-NaF has been shown in lesions associated with acute coronary syndromes and is considered to reflect the rate of microcalcification occurring in response to coronary inflammation. ^{18}F-NaF PET tracer holds promise in distinguishing high-risk plaques. Technical challenges exist in coronary ^{18}F-NaF PET imaging, these include CTA-PET registration, quantification, and motion correction.

Nuclear Imaging for Cardiac Amyloidosis

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Cardiac amyloidosis is a creepy killer, sneaking into the patient, turning up insidiously with non-specific symptoms and usually being detected late when the heart is already heavily affected. Awareness is the first step for diagnosis that is further based on imaging techniques and tissue analysis of heart or other tissues. Because of ongoing extracellular deposition of amyloid fibrils, cardiac walls thicken and become stiff. Ultrasound and Magnetic Resonance Imaging (MRI) can detect both thickened ventricular walls and systolic/diastolic dysfunction. However, many other heart diseases can present the same echocardiographic and MRI phenotype. Furthermore these findings become evident only in a relatively advanced stage of the disease, whereas an early diagnosis is a prerequisite for any efficacious therapy in systemic amyloidosis! So other diagnostic-ideally non-invasive-techniques are needed in order to face the multiple clinical needs of physicians treating patients with suspected or definite amyloidosis. Nuclear medicine has gained a precise role in this context.

Several nuclear medicine imaging techniques have become available for the diagnosis and prognostic stratification of cardiac amyloidosis during the last two decades. The different classes of radiopharmaceuticals have the potential to bind different constituents of the amyloidotic infiltrates, with some relevant differences among the various etiologic types of amyloidosis and the different organs and tissues involved:

- Serum amyloid P component (SAP) binds in a calcium-dependent way to all amyloid infiltrates, but fails to image cardiac amyloid probably because of its large molecular size
- Aprotinin, a bovine anti-serine protease which binds to amyloid with an unknown mechanism, has also been used in the past to image cardiac amyloid with disappointing results
- Antibodies raised against a common epitope of amyloid fibrils were not able to visualize cardiac amyloid
- Bone seeking tracers (in particular diphosphonates) image cardiac amyloid of the ATTR type very specifically and early and can be used to differentiate between the amyloid types, since AL amyloid shows only weak or no imaging at all. The nature of this specific binding to ATTR amyloid has not been clarified yet
- PET tracers derived from the amyloid stain thioflavin, have been recently used for cardiac amyloid with still inconclusive clinical results
- Iodine-123 labelled metaiodobenzylguanidine ([^{123}I]-MIBG) can be used as a functional tracer showing cardiac sympathetic denervation in early stages of amyloid deposition.

This presentation focuses on the background of the commonly used modalities (bone seeking tracers, [^{123}I]-MIBG and positron emission tomography (PET)),

their present clinical applications, and future clinical perspectives in imaging patients with (suspected) cardiac amyloidosis.

Pros and Cons of Nuclear Medicine Information Systems: Is Venus Beautiful?

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Background: The traditional paper-based system of booking, filing, and reporting has been completely replaced by a Nuclear Medicine Information System (NMIS) called Venus Nicesoft at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH). This digital migration has generally improved records keeping, time management and overall service delivery. Venus Information System (VIS) is a web based application; the software is developed on a server and can be accessed from any computer connected to the network using a web browser. VIS provides the necessary workflow steps like authenticated application access, transfer of patient data to the camera room, radiopharmacy management, digital reporting by authorized personnel. **Aim:** The purpose of this study is to highlight the advantages and disadvantages of using NMIS. **Method:** An anonymous audit which included 10 Radiographers and 15 Doctors (registrars and consultants) was performed in the form of a questionnaire. Both the Doctors and Radiographers were asked 10 similar questions regarding the advantages and disadvantages of using Venus Information System (questions will be incorporated in the final presentation). The participants were allowed up to 10 minutes to answer the questionnaire in a classroom format to minimize bias. **Results:** 60% (15/25) of participants had already been using Venus for more than one year, 36% (9/25) of participants for more than 6 months but less than a year and only 4% (1/25) of participants for less than 6 months. The majority (76%) of participants considered the system to be an advantage while less than a fifth (19%) found it to be a disadvantage. The remaining 5% were undecided. Only two of the ten statements used in the questionnaire were found to be viewed as disadvantageous to the participants. Firstly, two-thirds (66,6%) of doctors found the "HTML format of typing" to be a disadvantage and then 60% of radiographers and just more than half of the doctors (53%) found "the dependency of the system on the hospital network" to be a disadvantage. **Conclusion:** NMIS basically evolved the needs of both nuclear medicine radiographers and physicians and proved to be an essential tool that contributes to effective service delivery. Despite the very few thorny issues mentioned above as two concerned statements, the use of NMIS should be explored by busy nuclear medicine practices to improve and monitor their work flow.

Histopathological Molecular Subtypes of Breast Cancer as a Guide for Routine Posttreatment Skeletal Scintigraphy

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Background: Breast cancer is the commonest female cancer worldwide and the presence of metastasis is the most important factor affecting the overall survival of patients, with skeletal metastasis being the most frequent. The molecular subtypes of breast cancer have distinct biological features and are generally used as a guide for treatment and prognosis rather than as a guide for the post treatment surveillance and follow up of breast cancer patients. **Aim:** This study is aimed at assessing possible association between the various breast cancer molecular subtypes and scintigraphically detected skeletal metastases and to develop a guideline to improve the use of skeletal scintigraphy in the post treatment follow-up of patients with early breast cancer. **Methods:** This study is a 5 years retrospective study of breast cancer patients who had routine skeletal scintigraphy at the department of Nuclear medicine of DGMAH (2011-2015). The patients were classified into four molecular subtypes; Luminal A, Luminal B, HER2-enriched and Triple negative subtypes based on the expression of hormone and human epidermal growth factor 2 receptors (ER, PR, and HER2). A review of skeletal scintigraphy performed routinely on the patients (baseline plus at least one follow up scan within 24 months of presentation) further classified each class of molecular subtype into two groups of those with or without scintigraphic evidence of skeletal metastases. **Results:** A total of 202 (two hundred and two) patients were eligible for the study, mean age was 57.9 years at first presentation, most patients (77.4%) had advanced disease (stages 3 and 4). ER, PR and HER2 receptor positivity was 72%, 51% and 21% respectively. Almost half of the study population (45%) was of the Luminal B molecular subtype while Luminal A, non-luminal HER2 and triple negative subtypes were 22%, 6% and 27% respectively. Fifty-two percent (52%) of the study population developed skeletal metastases during the course of follow up. The prevalence rate for skeletal metastases was highest in the HER-2 enriched subtype (77%) while the Luminal A, B and triple negative subtypes had rates of 66%, 54% and 33% respectively. A statistically significant association existed between molecular subtypes and scintigraphic detected skeletal metastasis (p-value-0.02521). **Conclusion:** Breast cancer molecular subtypes are associated with different pattern of skeletal metastasis; routine post treatment follow

up using skeletal scintigraphy may be guided by the distinct molecular subtypes in which the patient belongs in addition to existing other criteria like stage of disease and the presence of bone pain.

Ethics/Training

Session 6: 10h30: Chairperson: R Dierckx
The State of Nuclear Medicine Training in the USA

L E De Blanch[1]
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- Residency options
- Residency positions
- Number of residents currently in training
- The effect of new preferred training in Diagnostic Radiology
- Current and projected job options
- Nuclear Medicine future

Training in the Netherlands

R Dierckx[1]
[1]Department of Nuclear Medicine, University Medical Center, Groningin, Netherlands

In the Netherlands a new common trunk training program for radiology and nuclear medicine (the so called CORONA) was implemented. Drivers were the breakthrough of hybrid systems, the request of the patient for a one-stop-shop and the demand of the referring physician for an integrated report. The program was agreed upon by both professional societies in 2013, worked out in 2014 and implemented in 2015. The prerequisite by the government was that 5 years of training in radiology and 5 years in nuclear medicine would result in a new common training program (and in a new mathematics) of 5 years. In this context the program consists of 2.5 years common trunk training in radiology, including several weeks training in nuclear medicine. The one year of training in internal medicine in the previous program of nuclear medicine is supposed to be amounted for by the present obligatory multidisciplinary meetings. In the last 2.5 years of the program the option of a further differentiation in nuclear radiology is foreseen. Over this limited time since its establishment the CORONA has resulted in the radiology taking the lead of the unified departments and of the training in most university medical centers in the Netherlands, in general recognition by the heads of radiology of the assets of nuclear medicine, in an increase of the knowledge and certification (so called cross over) of the existing staff, however also in a decrease of the role of nuclear medicine physicians in the Netherlands with a rather isolated position in Europe and in a decrease of the number of candidates for the new program of nuclear radiology as compared to the numbers previously in training for nuclear medicine. Related causes and envisioned solutions to address the aforementioned problems are discussed.

Nuclear Medicine Training in the UK

J Buscombe[1]
[1]President, British Nuclear Medicine Society, United Kingdom

To understand the training in nuclear medicine in the UK it is necessary to understand the legal framework for post-graduate medical training in the UK. This has evolved since 1518 when the Royal College of Physicians was formed and operates as a form of guild. Nuclear Medicine training was informal but was loosely linked to endocrinology until 1989 when it was recognised as a separate specialty. It is one of the 32 constituent specialties of the Royal College of Physicians of London and presently the 4th smallest with 80 specialists.
The present system is that the General Medical Council of the United Kingdom approves the training curriculum, the training is delivered by the National Health Service and the quality is monitored by the Royal Colleges. Nuclear Medicine is one of only 2 specialties were our knowledge based assessment is a University degree (A Post Graduate diploma of Kings College, London). Generally Universities play no role in specialty training. In 2010 it was recognised that with the advent of hybrid imaging there needed to be a significant radiological component to training in nuclear medicine. Two options were reviewed one was to merge training into radiology but with an additional 6th year training in cardiology and therapy tagged on the end or b) a full 6 years of integrated training and nuclear medicine would remain a separate specialty. These options were then sent out to all nuclear medicine trainees, trainees, the RCP, The Royal College or radiologists and the BNMS who all agreed option B was best.
Therefore a new 6 year integrated training course was set up with 80% radiology, 20% nuclear Medicine in years 1-3 and 20% radiology and 80% nuclear medicine in years 4-6. All applicants had to completed 2-3 years internal medicine and have their MRCP before they could apply to train in nuclear medicine. Each trainee would also gain the FRCR and the PGD in nuclear medicine and have dual specialisation in clinical radiology and nuclear medicine.

Nuclear Medicine Training in Belgium

O Gheysens[1]
[1]Department of Nuclear Medicine, University of Leuven, Leuven, Belgium

The training is based on a ministerial decree of 1996 with specific criteria for nuclear medicine and a decree of 2014 with more general criteria for residents in training.
The training consists of 5 years which is divided into 2 years of internal medicine followed by 3 years of nuclear medicine. The general rule is that minimum 12 months should be done in a university hospital and 12 months in a non-university hospital and it is allowed to do maximum 1/3 of the training abroad.
During residency, the candidate should perform clinical work, attend multidisciplinary meetings, symposia and should follow several mandatory theoretical courses that are evaluated by a formal examination. In addition, the candidate should have one publication or presentation at a conference, but there is currently no mandatory final examination or master thesis, however additional criteria can be required by the coordinating residency supervisor.
There have been attempts to reform the specific criteria for nuclear medicine in order to allow a training in other disciplines (e. g. radiology, currently only a maximum period of six months in neurology is allowed), and to put more emphasis on hybrid imaging and radionuclide therapies. To date, no consensus has been reached and discussions are ongoing.

Nuclear Medicine Training in South Africa

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Nuclear Medicine (NM) is a separate specialty in South Africa. It comprises a unique combination of diagnostic and therapeutic applications. In the diagnostic environment, it offers imaging and non-imaging investigations.
Several professional groups are indispensable for a fully functional NM environment. These include NM physicians, medical physicists, radiographers (NM technologists), and radiopharmacists/radiochemists. South Africa is in the fortunate position to have official training programmes for all these groups. South African institutions are also used for training people from other African countries in the various professional categories.
After qualification, each group has to register with a professional board of either the Health Professions Council of SA or the SA Pharmacy Council before they are allowed to practice.
NM physicians enroll for a 4 year university training programme, and on successful completion obtain a fellowship of the College of Nuclear Physicians of the Colleges of Medicine of South Africa, and an MMed (NM) degree from the specific university, after submission of a research project. Radiographers train at various universities of technology, while medical physicists and radiopharmacists all specialize through masters programmes.
The presentation will give an overview of the different training programmes in South Africa.

Oncology/Therapy

Session 7: 13h25: Chairpersons: W Oyen/AB Rahmani

18F-FDG PET-CT in Oncology: Appropriateness Criteria

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18F-FDG PET/CT is an established imaging modality in routine oncological practice and trials. The main role of 18F-FDG PET/CT includes (a) diagnosis of primary malignancy (b) differentiation of benign and malignant lesions (c) staging and restaging (d) response evaluation (e) detecting tumor recurrence, (f) image guided biopsy and (g) radiotherapy planning. However, this cannot be universally applied to all cancers. There are several recommended appropriateness criteria published by various national and international nuclear medicine societies for the use of 18F-FDG. In this presentation, I would like to discuss the Appropriateness Criteria for the use 18F-FDG PET/CT in common cancers (advantages and limitations).

Lu-177 Labeled PSMA Radioligand Therapy of Metastasized, Castrate-Resistant Prostate Cancer: Long Term Outcome of Precison Oncology after 5 Years' Experience at the Theranostics Center Bad Berka

Richard P. Baum[1], Harshad R. Kulkarni[1], Aviral Singh[1], Thomas Langbein[1], Christiane Schuchardt[1], Jingjing Zhang[1], Coline Lehmann[1]
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^{177}Lu-DOTAGA PSMA I and T: Based on the principles of targeted radionuclide therapy, ^{177}Lu labelled ligands binding specific to PSMA were developed using DOTAGA as chelator *(Weineisen M et al. 2015)*. PSMA radioligand therapy (PRLT) with ^{177}Lu-DOTAGA PSMA ligands was performed in 56 progressive, metastasized, castrate-resistant prostate cancer (mCRPC) patients (*Baum et al. 2016*). Ga-68 PSMA PET/CT was used for patient selection and follow-up after PRLT. Hematological status, renal function and serum prostate specific antigen (PSA) levels were documented before and

after therapy. Dosimetry was performed in 30 patients. ^{177}Lu DOTAGA PSMA small molecule demonstrated very high tumor uptake, rapid blood clearance and fast renal washout resulting in high absorbed tumor doses (median, 3.3 mGy/MBq) as compared to normal organs. All patients tolerated the therapy without any acute adverse effects. Except mild reversible xerostomia in two patients, no long-term side effect was observed. No relevant hematotoxicity or renal impairment occurred. Decrease in PSA was noted in 45/56 (80%) and pain significantly reduced in 33% of patients. In 25 patients, followed up at least 6 months after ≥2 PSMA-RLT cycles, molecular response evaluation (^{68}Ga-PSMA PET/CT) revealed partial remission (PR) in 14, stable disease (SD) in 2 and progressive disease (PD) in 9 patients. Contrast-enhanced CT exhibited PR in 5, SD in 13, and PD in 7 patients. The median progression-free survival was 13.7 months, and the median overall survival was not reached at follow-up of 28 months. **^{177}Lu-PSMA-617:** Between April 2013 and June 2018, intention-to-treat analysis was performed in 274 patients (mean age 71 years, mean Gleason score 8) with mCRPC. They received 1 to 11 PRLT cycles (total 824 courses) using 3.5-11.7 GBq (mean 6.7 GBq) of Lu-177 labeled PSMA ligand. Previous treatments included surgery, external beam radiation, chemotherapy, androgen deprivation and Ra-223 chloride. The most frequent sites of metastases were bone (n=228 patients), lymph node (209), liver (34) and lungs (36). Ga-68 PSMA PET/CT was used for initial evaluation and therapy response assessment (THERANOSTICS concept). Laboratory parameters included complete blood count, renal and liver function, electrolytes etc. PSA levels were documented before and regularly after therapy. Any PSA decline was observed in 72 % of all patients, the best response was biochemical complete remission (PSA=0.0 ng/ml). Decrease in PSA by >50% was seen in 53% of cases. Median progression-free survival (according to RECIST 1.1) was 9.8 months. Median overall survival (at 61 months follow-up) was 30.9 months (96 patients deceased). G3-4 hematological toxicity was observed in <5% of patients and was more frequently associated with previous chemotherapy or Ra-223 treatment. Nephrotoxicity was not observed in any of the 274 patients treated, even if there was only a single functioning kidney present (n=17). Pain reduced dramatically and the quality of life improved significantly in symptomatic patients (EORTC questionnaire). In general, the patients tolerated the treatment very well with no severe acute or long-term side effects (observation period 64 months). The most common adverse effect was mild fatigue lasting for a few days after therapy. Radiation effect on salivary gland function was assessed using dynamic salivary gland scintigraphy before and after PRLT. Using a standardized questionnaire, <5% of patients reported mild dryness of mouth, which was mostly reversible. First line (de novo) Lu-177 PSMA radioligand therapy was effective in 11 non-castrate metastatic prostate cancer, offering a significant survival benefit. Patients demonstrating a PSA decline of more than 50% after at least two PRLT cycles lived significantly longer. Additional treatment with newer antiandrogen agents (Abiraterone or Enzalutamide) in combination with 177Lu PRLT also prolonged survival. **Targeted Alpha Radioligand Therapy:** The feasibility, toxicity and efficacy of targeted alpha radioligand therapy (ART) in end-stage, metastatic, treatment-resistant prostate cancer, having progressed under Lu-177 PSMA radioligand therapy, were evaluated in a pilot study in 10 patients with Bismuth-213 PSMA-617 (1-2 cycles, 2-4 applications per cycle). Bi-213 ($t_{1/2}$ 46 minutes) was obtained from an Ac-225/Bi-213 generator (provided by Isotope Technologies Garching (ITM), Munich Germany). The median administered activity of Bi-213 PSMA per cycle was 390 MBq (155 – 623 MBq). All patients tolerated the therapy very well without any acute adverse effects. Decrease in PSA was noted in 43 % of patients. With the administered radioactivities mentioned, no significant acute/subacute toxicity was noted and minor responses could be demonstrated. Since February 2018, 22 patients have been treated with Actinium-225 PSMA-617 or with a combination of Lu-177/Ac-225 PSMA (TANDEM-ART). The results are extremely promising and will be presented in more detail. **Conclusions:** PSMA Radioligand Therapy with ^{177}Lu-PSMA has been performed since April 2013 in 274 patients (total number of 824 administered treatment cycles). PRLT of mCRPC is feasible, safe (especially no nephrotoxicity as noted without renal protection) and effective with appropriate selection and follow-up of patients by ^{68}Ga-PSMA PET/CT applying the concept of Theranostics *(Baum et al. 2015, Kulkarni et al. 2016).* Targeted alpha radioligand therapy using Ac-225 PSMA or TANDEM-ART appears to be extremely promising for Precision Oncology of end-stage metastatic treatment-resistant prostate cancer, progressing after castration, newer hormonal agents, chemotherapy as well as after progression under Lu-177 PRLT. Randomized clinical trials have now started to confirm the results of this extremely promising new concept of molecular targeted radiotherapy.

^{225}Ac-PSMA-617 in Advanced Prostate Cancer

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The limited effective therapies available for castration-resistant prostate cancer (mCRPC) despite the high mortality and morbidity associated with this aggressive disease emphasizes a need for continued effort to

broaden treatment options available for this phase of the disease. Targeted radionuclide therapy technique has been successfully used in the treatment of different cancers including differentiated thyroid carcinoma and metastatic neuroendocrine neoplasms. The prostate cancer cells express the prostate-specific membrane antigen (PSMA) on its surface. Higher level of PSMA expression is found in metastatic and castration-resistant forms of prostate cancer. PSMA has been targeted for imaging and therapy of prostate cancer. The earlier experience with PSMA-based radioligand therapy (RLT) was with the use of Luttetium-177 (^{177}Lu), a beta emitter. The effectiveness of ^{177}Lu-PSMA RLT has been shown in several studies with tolerable side effects. Up to about 30% of patients will however not respond to ^{177}Lu-PSMA RLT.

Fortunately, ^{225}Ac-Prostate-specific membrane antigen (PSMA)-617, initially developed and characterised at JRC Karlsruhe in 2013, is a highly promising novel compound for therapy of prostate cancer. A remarkable therapeutic efficacy has been demonstrated in heavily pre-treated metastatic castration-resistant prostate cancer (mCRPC) patients, with xerostomia as the main side effect in Heidelberg, Germany. The excellent results have since led to University of Pretoria exploring the impact of ^{225}Ac-PSMA-617 in both heavily and less heavily pre-treated patients and also addressing the major challenge of ^{225}Ac-PSMA-617 therapy of damage to the salivary glands.

Conclusions/lessons from our experience:

Efficacy

- Tumor shrinkage
- Symptom relief and QoL improvement
- Biomarker reduction
- Impact on survival.

Tolerability

- Nephro and Hematological toxicity well tolerated (limited/none)
- Xerostomia (mainly G1).

Interdisciplinary approach is essential for the implementation of ^{225}AC-PSMA-617

- Indicated for extensive skeletal metastases – not suitable for ^{177}Lu PSMA and for patients not qualifying for other conventional therapies or refuse conventional therapies
- Determine the activity/dose (de-escalation approach)
- Need for a prospective Phase Trial I/II
- Explore cyclotron based production of ^{225}Ac.

Radiopharmaceutical Dosimetry

B Sattler[1]

[1]Department of Nuclear Medicine, University of Leipzig, Germany

This talk will give an insight in image acquisition and quantification for radiopharmaceutical dosimetry with a focus on diagnostic PET radiopharmaceuticals. There will be given basic explanations/repetitions on some dose quantities for radiation risk assessment. The MIRD concept will be shortly re-visited to give a comprehensive foundation for what is necessary to determine in incorporation-dosimetry. PET metrics will be used in preparation of image based incorporation-dosimetry. Moreover, the care-and thoughtful study design in the framework of the determination or re-assessment of the (radiation-) safety and tolerability of novel or well-known diagnostic radiotracers, respectively, will be alluded on. Examples will be utilized to illustrate the image analysis procedure, the steps of calculation of the absorbed doses in the target organs and potential organs at risk until the conversion factor to determine the effective dose per an amount of activity administered [μSv/MBq]. This measure of the radiation risk will be discussed in the scenario of other risks. Different orders of magnitude of radiation exposure caused by systemic application of different radioligands and –nuclides will be compared and discussed.

Saturday 11th August, 2018 Track B Physics

Session 8: 8h00: Chairpersons: P Slomka/H Thlapi

SPECT-CT-Quantification

B Sattler[1]

[1]Department of Nuclear Medicine, University of Leipzig, Germany

This presentation will shortly repeat the basic principles of gamma camera scintigraphic imaging and the limitations if it comes to activity quantification using hybrid SPECT/CT. Techniques will be shown on how the limitations introduced by photon attenuation, photon scatter and how increased computation power allows for a more complex involvement of the respective corrections already in the reconstruction process can be achieved. Moreover, iterative reconstruction techniques allow the hardware and performance characteristics of the imaging system and circumstances to be taken into account. The process calibration of the gamma camera system itself and cross-calibration with other activity measuring peripheral devices such as activity meters (dose calibrators) or well counters will be thoroughly explained. Truly quantitative activity metrics starting with an exact determination of the activity concentration become available also in the SPECT/CT imaging scenario. We will discuss the importance of that feature for diagnosis (e.g. comparison with a normal data base) and/or in assessment of response to radionuclide therapy. Moreover, this feature becomes decisively

important, for image based planning, monitoring and verification of radionuclide therapies using radionuclides that emit photon radiation along with particle radiation causing the primary intended, therapeutically relevant radiation effect.

Iterative Image Reconstruction in Positron Emission Tomography

M Mix[1]
[1]Department of Nuclear Medicine, University of Freiberg, Freiburg, Germany

PET imaging has substantially benefited from the introduction of iterative, statistical image reconstruction. The main concepts of these iterative algorithms were published decades ago and in the meantime, they were established in clinical routine. This talk gives an overview of data acquisition (list-mode, sinogram-mode) and iterative reconstruction in modern PET with and without time of flight information. The very popular maximum likelihood algorithm will be explained with its main parameters (# of iterations, subsets and regularization). Existing advantages and known challenges like convergence and noise behaviour will be discussed.
One important feature of PET is the possibility of an accurate quantification of tracer accumulation (e. g. kBq/cc). Corrections for random and scattered coincidences have to be included into the statistical reconstruction algorithms in the same way like attenuation. The use of CT information for attenuation correction implies an additional source of image artefacts and quantitative inaccuracy. While CT produces a snapshot of the HU-density in the patient's body in a few seconds, whole-body PET acquisition takes place over several minutes and over many breathing cycles. Therefore misalignment may occur, which should be avoided with suitable CT acquisition protocols. Remaining misalignment should be corrected additionally before the CT can be used for attenuation correction. CT artefacts coming from metal implants or contrast agents may also influences attenuation correction and thereby PET image quantification. Strategies for finding the optimal acquisition protocol and setting of reconstruction parameters for different PET indications and radiotracers are still under research. Even if standardisation of imaging protocols between different sites has improved, adaption for different PET/CT scanners may remain.

Radiology

Session 9: 09h00: Chairpersons: M Mix/R Clauss
Groups of Lymph Nodes and the Neck Spaces

C Minné[1]
[1]Department of Radiology, Dr George Mukhari Academic Hospital, SMU Health Sciences University, GaRankuwa, Pretoria, South Africa

CT anatomy of the pharynx and larynx. The structures most frequently affected by tumor (or infection) and their corresponding lymphatic drainage: our main application is PET CT after all. We see things in 3 axes, and we seldom look at planar images in that region.

Iodinated Contrast Related Complications

W Greeff[1]
[1]Department of Radiology, Dr George Mukhari Academic Hospital, SMU Health Sciences University, GaRankuwa, Pretoria, South Africa

This lecture provides a brief introduction to the various types of contrast media and where iodinated contrast media fits into the picture. We will discuss the safe and appropriate use of iodinated contrast media as well as general risk factors for the development of complications. This is followed by examples of complications and their appropriate management.

Nuclear Medicine Technology

Session 10: 10h30: Chairpersons: P Nemutaduni/C Naidoo
Practical Aspects of Managing a Paediatric Patient for a Nuclear Medicine Procedure (RG03)

M Jassen[1], **F Smith**[1], **S More**[1], **A Brink**[1]
[1]Department of Nuclear Medicine, Red Cross War Memorial Children's Hospital, Cape Town, South Africa

Background: Nuclear Medicine imaging plays an important role in staging and management of patients regardless of their age. Scanning or even management of the paediatric patient can be challenging even for the most experienced Radiographer. The stressors of scanning a paediatric patient are related to the emotional state of the patient, parents/guardians and that of the radiographer. **Aim:** The aims of this presentation are to give practical advice and tips which will be able to assist the Nuclear Medicine Radiographer in imaging a paediatric patient. The implementation of these practical aspects will increase the compliance of the paediatric patient, increase image quality and result in superior diagnostic confidence. **Methods:** During the course of the presentation, some key aspects will be highlighted that needs to be taken into consideration when receiving a Scan request in your department. These aspects will have an impact on the quality of images produced and

the overall patient satisfaction. Pertinent points on how to interact with the different age groups, on what appropriate immobilization techniques will be useful and methods for distraction during image acquisition will be addressed. **Conclusion:** Never lie or deceive your patient simply because they are children. Paediatric patients are referred to your department to assist in finding the cause of their illnesses, thus give your patient the best care possible. In return, you will gain the co-operation and trust of the patient as well as their parents/guardians.

Sentinel Node Mapping

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The sentinel node is defined as the first node encountered by lymphatic vessels draining a tumour. Lymphatic flow from a particular area of the body tends to be orderly, with drainage to a first node (the sentinel node) and then from this sentinel node further "downstream" to successive nodes, before finally re-entering the systemic circulation. Metastases are most likely to affect the sentinel node first and from this node, will "seed" further down the lymphatic system to other nodes and distant sites. Therefore, the ability to accurately identify (and hence biopsy) this sentinel node is invaluable, as a negative sentinel node not only makes it highly unlikely that other nodes are affected, but also spares the patient wide nodal dissection, which is associated with significant morbidity. Lymphoscintigraphy involves the injection of radiolabelled particles (variety of techniques) which are transported by the lymphatics, followed by sequential gamma camera imaging. It is a valuable, minimally invasive procedure which is able to demonstrate ("map") the lymphatic drainage pathway of a tumour, locate sentinel node(s) (which may be outside the usual nodal basin) and when used in conjunction with a hand held gamma probe, it has the added advantage of pre-operative (skin projections/markings) and intra-operative localization of the sentinel node (which may not always in a defined anatomical area). The identified sentinel node can then undergo intra-operative frozen section and histopathological analysis. **Breast Cancer:** Nodal status remains the single most important prognostic factor in breast cancer, as the presence of regional node metastases decreases the 5-yr survival rate by 28-40%, therefore staging of the axilla, especially with clinically impalpable nodes, is of utmost importance. Traditional axillary dissection in breast cancer surgery yields 15-25 lymph nodes which are then sectioned and analysed. However, due to the large number of dissected nodes, not only can micro-metastases be missed, but wide axillary nodal dissection is associated with significant morbidity. Therefore being able to identify the most likely metastatic nodes (sentinel nodes) allows more focused and accurate histopathological analysis of a few (1-3) lymph nodes and permits the sparing of wide axillary dissection (reduced morbidity). Breast cancer patients who may benefit from sentinel lymph node biopsy range from 10% to >70%, according to tumour size (T4 to T1). Use of lymphoscintigraphy and gamma probes have reported success rates of >94% in the detection of sentinel lymph nodes in breast cancer. **Malignant Melanoma:** Increasing incidence since the early 1970's with average 5-yr mortality rate of 20%. Main prognostic factors are: thickness; ulceration and the presence of metastatic sentinel lymph nodes (included in the TNM staging). Patients without metastases at sentinel lymph node biopsy can avoid nodal basin dissection (associated morbidity) whereas those with metastatic sentinel lymph nodes might benefit from additional treatments. Therefore a definitive role for lymphoscintigraphy and the use of hand held gamma probe exists, to: locate the sentinel lymph node, not only as a guide to minimal access surgery but also because melanomas located in the extremities drain to the groin or axilla, but melanomas located in the head, neck and trunk drain much less predictably. Use of lymphoscintigraphy and gamma probes have reported success rates of 98-99% in the detection of sentinel lymph nodes in malignant melanoma.

The Role of Medical Physics in Nuclear Medicine: Government Institutions versus Private Practice

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Background and Objectives: Medical physicists working in the field of nuclear medicine are specialised in that essential role in modern medicine. The roles and responsibilities of the nuclear medicine physicist are diverse, which include dosimetry, image quality, optimization, research and teaching, radiation safety, quality assurance and equipment management. In South Africa the governmental institutions will often appoint full-time medical physicists, versus the private practice appointment of part-time. Very often part-time vs. full time appointment may influence the roles and responsibilities of the nuclear medicine physicist. This talk however will demonstrate that this should not be the case, and that the roles and responsibilities of a nuclear medicine physicist as defined should remain the same but applied differently. **Methods:** Current roles and responsibilities for nuclear medicine physicists in private vs. government institutions in South Africa were analysed. This was done by comparing five (5) private practices to three (3) governmental institutions. Based on these results a South African nuclear medicine physicist' roles and responsibilities were determined. This standard was then

compared to the roles and responsibilities of a nuclear medicine physicist as defined by the International Atomic Energy Agency (IAEA). **Results:** Differences in the nuclear medicine physicist' roles and responsibilities for part-time (private) vs. full-time (government) were identified. Some of the responsibilities of the nuclear medicine physicist are not applied to part-time (private) institutions, which should not be the case. The roles and responsibilities of a South African nuclear medicine physicist are similar to that defined by the IAEA. **Conclusion**: The study provided a review of the roles and responsibilities of a nuclear medicine physicist in South Africa. The part time (private) vs. full time (governmental) roles should be similar, with the medical physicist overseeing dosimetry, image quality, optimization, radiation safety, quality assurance and equipment management.

Radiopharmacy

Session 11: 13h10: Chairpersons: J le Roux/B Summers

Current Good Manufacturing Practice c-Good Manufacturing Practice

U Bhonsle[1]

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Radiopharmaceuticals are radioactive pharmaceuticals. Radiopharmaceutical manufacturing and clinical use is subject to a number of pharmaceutical and radiation protection regulations. The talk will outline the current Good Manufacturing Practice (c-GMP) related to SPECT radiopharmaceuticals, PET radiopharmaceuticals, Therapeutic radiopharmaceuticals. The presentation will also comment on impact of other clinical procedures such as on-site blood cell radiolabeling procedures on C-GMP regulatory compliance. The talk will highlight considerations for efficient and cost-effective implementation of over all regulatory compliance (Radiation as well as Pharmaceutical) related to the onsite or central radiopharmacies. The talk will highlight issues encountered in implementation of c-GMP and lessons to be learned in African context.

Therapeutic Radiopharmaceuticals – Importance of Preclinical Investigation for Effective Clinical Application

E Janevik[1]

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Within the last decade, there has been an increasing interest in developing new radiopharmaceuticals for therapy, especially targeted radionuclide therapy (RNT) with labelled monoclonal antibodies (mAbs) and peptides as a complementary modality for the treatment of certain cancers.

Intact antibodies and their truncated counterparts (eg, Fab, scFv fragments) are generally exquisitely specific and selective vectors, enabling recognition of individual cancer-associated molecular phenotypes against a complex and dynamic biomolecular background. Complementary alignment of these advantages with unique properties of radionuclides is a defining paradigm in both radioimmunoimaging and radioimmunotherapy, which remain some of the most adept and promising tools for cancer diagnosis and treatment.

How many potential radiopfarmaceuticals and how many can be apropriate for for therapy is the crucial approach, especialy if we can considered that only less than 5% of in vitro targets allow development of an in vivo probe as potential radiopfarmaceutical for therapy. The most important criteras before to start preclinical investigation, as the first and the most important step of introduction and treat one radiopharmaceutical as potential for therapy are:

- High target activity and concentration including affinity and specificity, absence of biological barriers (i. e. endothelium, blood brain barrier,...) and stable labeling of compound
- Low background activity, that comprehend non-specific accumulation, circulating or interstitial activity and renal or hepatic elimination
- Signal amplification as cell trapping, enzymatic conversion and "Reporter" radioactive molecules.

Preclinical studies for therapeutic radiopharmaceuticals should be designed to assess:

- The *in vivo* stability of the radionuclide complex
- The animal biodistribution of the radionuclide
- The potential chemical toxicity
- The radiation exposure of tissues.

Data required to establish preclinical safety of radiopharmaceuticals include

- In vitro target/receptor profiling including pharmacodynamics
- Pharmacokinetics
- Potential chemical toxicity including antigenicity
- Radiation exposure of tissues
- Late radiation toxicity
- The dose evoking pharmacologic activity or antigenicity, and
- The minimum radioactivity dose needed for satisfactory imaging.

For therapeutic radiopharmaceuticals, safety is determined by the margin between-the dose exceeding organ tolerance or inducing late radiation toxicity, and-the minimum efficacious dose.

The goal of this paper is to discuss how translational potency can be maximized through rational selection of antibody-

nuclide couples for therapy in preclinical models, using our experience introducing ready to use kit formulation of freeze dries conjugated and potentialy to give some idea how to come back to the radioimmunoimaging using the new potential PET radionuclide.

Compounding Radiopharmaceuticals for PET and Therapy

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Most SPECT radiopharmaceuticals are manufactured by commercial suppliers, and staff in Nuclear Medicine units do no more than mixing a sterile radioactive solution with a sterile vial of ingredients prior to dispensing patient doses. In recent years, the situation has changed, with an increasing demand for products that are not commercially available, and are not prepared in a single step from approved commercial components. We should ask ourselves what the requirements for in-house preparation of these more complex preparations are.

International guidelines for the small-scale compounding of radiopharmaceuticals will be summarised to illustrate the risks and challenges of moving beyond Tc-99m generators and kits in a Nuclear Medicine unit. These guidelines address a wide range of factors, including personnel and their responsibilities, risk assessment and quality assurance facilities and equipment, documentation, and internal audits. Compounding of Ga-68 and Lu-177 products will be discussed to illustrate the requirements and challenges of current Good Radiopharmacy Practice.

^{68}Ga Based Infection Imaging Agents: A Progress Report

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Background/Aim: PET/CT imaging plays an important role in molecular imaging and fortunately diversification of the use of the well-known but nonspecific ^{18}F-Fluorodeoxyglucose-(^{18}F-FDG) PET/CT to the use of radiometals such as ^{68}Ga has created many new opportunities. The HIV/AIDS pandemic in South Africa has helped to fuel tuberculosis (TB) morbidity and mortality. Although TB is curable, it is still the leading infectious cause of death after HIV, worldwide. The steady increase in resistant TB strains, comorbidities such as HIV/AIDS, diabetes and malignancies make it difficult to effectively manage TB; thereby augmenting the burden of TB and the cost of treatment. Current clinical tests are lacking specificity and accuracy to localize TB and bacterial infections and many pathogens simply do not grow on standard culturing plates. Clinical imaging such as computed tomography (CT) and magnetic resonance imaging (MRI) are challenged to detect bacterial infections and commercially available PET and SPECT infection imaging agents for cannot discriminate between bacterial infections and sterile inflammatory processes. In problematic case this is crucial for further clinical decision making. Hence the needs to develop bacteria-specific imaging tracers that are capable of targeting pathogens like TB. **Methods;** New developments in innovative tracer development can support the detection of infections. New approaches towards such probes are made using bacteria-unique sugars, vitamins, antimicrobial peptides and D-amino acids as bacteria-targeting vectors. A prerequisite is that the radiolabel should not alter the binding affinity of these molecules. As radiometals require a chelator, the best option for ^{68}Ga is to conjugate small peptides while ^{18}F affords more radiolabeling opportunities. **Results:** Our research in molecular imaging of infection will be discussed in particular the development of the world's-first ^{68}Ga-based PET imaging agent distinguishing between infection and inflammation; [^{68}Ga]Ga-UBI has progressed beyond preclinical evaluation. First-in-human studies under ethical approval at Steve Biko Academic Hospital have proven its capability to localize infectious foci even in immune compromised patients (for example in HIV positive patients). Clinical translation of novel PET-radiopharmaceuticals via a kit radiolabeling procedure has also been achieved in principle. Beyond [^{68}Ga] Ga-UBI, novel drugs such [^{68}Ga] Ga-CDP1 intend to be TB-specific. Wider coverage will also be given to other new probes that are investigated by other research groups in this field. **Conclusion;** The next generation imaging probes promise unparalleled and diverse opportunities for detecting and monitoring infection such as TB since molecular and cellular alterations occur earlier in a pathologic process, than structural changes do.

Determination of the Stability and Shelf Life of Noncarrier Added Lutetium (^{177}Lu n. c. a.) Produced at NTP Radioisotopes

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Background: Peptide Receptor Radiation Therapy (PRRT) or Radioligand Therapy (RLT) has been used for several years for the treatment of various tumours such as neuro-endocrine tumours and metastatic castration resistant prostate cancer. For the maximum therapeutic effect, high specific activity ^{177}Lu is required to maximise the ratio between the Dota derivatised peptide and ^{177}Lu. Lutetium-177 (^{177}Lu) can be produced by one of two routes i. e. the direct route of irradiating enriched ^{176}Lu producing carrier added ^{177}Lu, or by the indirect route of irradiating enriched ytterbium-176 (^{176}Yb), followed by the chemical separation of the lutetium and ytterbium. Non-carrier added ^{177}Lu n. c. a. produced by the indirect route has the advantages of higher specific activity, longer shelf life, lower Lu: ligand ratios during labelling, and no long-lived ^{177m}Lu. **Aim:** The aim of this project was the establishment of a stability programme for the determination of the shelf life of ^{177}Lu n. c. a. produced by the indirect production method. **Method:** Production of ^{177}Lu n. c. a. yields a bulk product, which is dispensed into the final product. Both products were sampled for quality control. The bulk product was analysed for 5 days after end of production (EOP) and the dispensed product for 11 days after dispensing. The radiochemical purity and the radiolabeling yield of ^{177}Lu n. c. a. were determined by thin layer chromatography. The radionuclidic purity was determined by gamma spectrometry. Radioactivity concentration was determined by weighing and activity counting of the sample in an ionisation chamber. The chemical purity and specific activity were measured on an ICP-MS. The sterility of the final product was determined by direct inoculation method from a fully decayed ^{177}Lu n. c. a. product and the endotoxin content was measured using a kinetic Turbidimetric method. **Results:** The results showed that the bulk product conformed to all the specifications up to 5 days after the EOP and the final product up to 11 days after dispensing from the bulk product up to 5 days after EOP. **Conclusion:** The results of this study show the product conformed to the specifications set in the European Pharmacopoeia. A shelf life of 4 days was allocated to the ^{177}Lu n. c. a. bulk product and a shelf life of 9 days (after dispensing from the bulk product up to 4 days after EOP) for the final product.

Microbiological Air Quality Monitoring in the Radiopharmacy of a Large South African Teaching Hospital

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Background: Air quality in the environment in which radiopharmaceuticals are prepared and dispensed can affect the sterility of the products. International guidelines recommend that radiopharmaceutical preparation and dispensing should be performed in a class A clean air environment within an EU grade C clean room. At our teaching hospital, we do not have facilities that meet these requirements. The question arose how far the air quality in our Radiopharmacy deviates from the recommended environment. **Aim:** To evaluate microbiological air quality in a South African radiopharmacy. **Methods:** Results of routine air testing in the Radiopharmacy were reviewed. Passive air sampling was done by exposing sterile blood agar settle plates for 2 hours in predetermined positions, 2 each inside the shielded laminar air flow cabinet for Tc-99m work (SLAF), in the cell labelling LAF (CLAF), and in the room. Samples were taken during work in the LAFs ("active", and while the LAFs were operating but not used ("resting"). After exposure the settle plates were incubated at 35 °C for 72 h, after which colony forming units (cfu) were counted. Results were also expressed as meeting or exceeding recommended limits for the sampling location. **Results:** Results of 938 settle plates exposed during the period October 2014 to February 2018 were evaluated. Of these 459 were placed in the SLAF, 70 in the CLAF and 346 in the room. In the SLAF, 6.9% exceeded the cfu limit for class A air during rest and 5.4% while working (difference not significant, T-test: $p>0.05$). In the CLAF, 10% (active) and 3% (resting) plates exceeded the class A limit. The room met limits for class C air during 91.0%, and class D 97.4% of sampling times respectively. Air quality was also tested during a period when the SLAF fan was not functioning correctly. During this period, 30% of the settle plates exceeded limits for class A. **Conclusion:** Despite the fact that our Radiopharmacy is not designed or maintained as a clean room, the air quality in the shielded LAF cabinet usually meets recommended specifications. Working in the SLAF cabinet does not affect the air quality. Reviewing techniques used in the CLAF may improve active air quality in this location. In further studies, the sterility results of Tc-99m radiopharmaceuticals prepared in the SLAF will be reviewed, and our air quality results will be compared with those of at least one other African Radiopharmacy.

Sunday 12 August, 2018

Neurology and Physics

Session 12: 08h00: Chairpersons: G Gnanasegaran/MDTHW Vangu

Clinical PET MRI connectomics

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Brain connectomics emphasize that brain is functioning on its connected networks whose connectomes are complex. Last few decades, topographical patterns of brain metabolism/structures were scrutinized to unravel the unique brain-disease attributes on the individual basis and failed in many brain diseases such as ADHD or autism spectrum disorders.
Connectomics of PET (single image per individuals) disclose only the group characteristics and resting-state fMRI define the individuals' connectivity patterns. Thus, combined PET/fMRI can yield the group characteristics of brain metabolism and connectivity of BOLD on individual bases and might help understand the individuals' probability of belonging to a specific group of brain diseases.
However, this endeavour of using PET/fMRI connectomics for clinical use had faced with the problems of 1) arbitrariness of setting threshold to make binary networks (graphs), 2) complex graph measures of network science impeding clear understanding, 3) neuroscientists' mistaken belief that topography analysis (SPM: statistical parametric mapping) shall elucidate the characteristic connectivity unique to brain diseases, and 4) other issues yet-to-be formulated/solved.
The first issue of arbitrariness was solved by adopting persistent homology of topology (mathematics) which was successfully applied to FDG PET, T1 MRI, MEG and activation fMRI (IEEE TMI, Neuroimage, Brain Connectivity, Hearing Research, Sci Rep, 2012-2017). The second problem was recently tackled by topological entropy analysis of the brain graphs, which also produced directed weighted brain graphs. I hypothesized that we could overcome the third problem using PET/fMRI while PET is showing group topographical pattern and resting-state fMRI individual characteristics on their dynamics. Furthermore, we needed novel statistical analysis methods of permutation and extended likelihood tests with or without hidden Markov field model.
Ultimate goal of classifying and prognosticating brain-disease patients need deep learning having special capability of performing unsupervised learning using scanty data. Generative or generative-adversarial networks (GAN), graph or relational neural networks are expected to help us to solve this job soon.

Parkinson's Imaging

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The diagnosis and differential diagnosis of Parkinson and Parkinsonian syndromes may be challenging in early stages of the disorders, when confronted with atypical symptoms or in the setting of comorbidity.
With this regard nuclear molecular imaging may play an important role, targeting the pre-and postsynaptic dopaminergic system using PET or SPECT or using perfusion SPECT or FDG PET.
For the latter, the latest findings of the multivariate analysis of FDG PET (GLIMPS project), especially in early stages, will be discussed.
Furthermore PET or SPET are used to target receptor systems, for example in the hart, showing changes related to involvement of the peripheral nervous system.
In this context new insights are developing regarding the course of the disorder, especially about the role of the brain-gut axis.
Finally, new tracers are being developed focusing on the related proteinopathies. Their present state will be discussed, providing a glimpse of future developments.

Resting Regional Brain Metabolism in Social Anxiety Disorder and the Effect of Moclobemide Therapy

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Introduction: While there is mounting evidence of abnormal *reactivity* of several brain regions in social anxiety disorder (SAD), and disrupted *functional connectivity* between these regions at rest, relatively little is known regarding resting regional neural activity in these structures, or how such activity is affected by pharmacotherapy. **Aim:** To detect differences in regional glucose metabolism between patients with SAD and healthy controls and to detect regional changes in glucose metabolism following treatment in SAD. **Methods:** In a prospective trial, using 2-deoxy-2-(F-18) fluoro-D-glucose positron emission tomography, we compared resting regional brain metabolism between SAD and matched healthy control groups; and in SAD participants before and after moclobemide therapy. Voxel-based analyses were confined to a predefined search volume at a voxel-level statistical threshold of p=0.001 (uncorrected) and cluster-level threshold of 0.05 (family-wise error corrected). A second, exploratory whole-brain analysis was conducted using a more liberal statistical threshold. All analyses were performed in

MATLAB (Mathworks R2014b). **Results:** Fifteen SAD participants and 15 matched controls were included in the group comparison. A subgroup of SAD participants (n=11) was included in the therapy effect comparison. No significant clusters were identified in the primary analysis. In the exploratory analysis, the SAD group exhibited increased metabolism in left fusiform gyrus and right temporal pole. After therapy, SAD participants exhibited reductions in regional metabolism in a medial dorsal prefrontal region and increases in right caudate, right insula and left postcentral gyrus. **Conclusion:** This study adds to the limited existing work on resting regional brain activity in SAD and the effects of therapy. The negative results of our primary analysis suggest that resting regional activity differences in the disorder, and moclobemide effect on regional metabolism, if present, are small. While the outcomes of our secondary analysis should be interpreted with caution, they may prove valuable in formulating future hypotheses or in pooled analyses.

The Role of Gallium 68 Citrate Positron Emission Tomography in the Management of Intracranial Tuberculosis

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Background: ^{18}F-FDG-PET/CT is useful in the management of tuberculosis (TB), especially in follow up of treatment. ^{18}F-FDG is considered the PET imaging tracer of choice in infection and inflammation, but its role in the assessment of intracranial lesions is limited as a result of an intracranial physiological accumulation in the brain due to high glucose metabolism. ^{68}Ga-citrate is another PET tracer that is known to image infection and inflammation. The radioisotope ^{68}Ga is relatively cheap, available, and can be labelled easily in nuclear medicine units without the need for highly skilled radiochemists or lab. **Aim:** To assess the use of ^{68}Ga-citrate in intracranial tuberculosis and comparison with ^{18}F-FDG, and compare the usefulness of ^{68}Ga-citrate PET/CT and TB at different sites. **Design/Methods:** We obtained approval from the health and ethics committee of the University of Pretoria. We recruited patients with histopathology confirmed or clinical diagnosis of TB over a six month period. All patients underwent at least one pair of PET/CT studies with ^{18}F-FDG and ^{68}Ga-citrate. The scans were done at least 24 hours apart but within 2 weeks of each other. The sites of all abnormal tracer accumulation were recorded. We counted all lesions due to TB, and we recorded the standardized uptake value (SUV) of each lesion. All the scans were acquired according to the EANM guidelines. The findings of the ^{18}F-FDG scans were compared to the ^{68}Ga-citrate PET/CT scans. **Results:** 18 patients were included, mean age was 35.67 ± 13.52 years, Male=7, Female 11. A total number of 218 lesions were considered to be due to TB. Overall, ^{68}Ga-citrate detected less lesions compared to ^{18}F-FDG (156 vs. 215, $p<0.0001$). ^{68}Ga citrate detected 78% of the lymph nodes, 75% of the lesions in skin and subcutaneous tissue, 33.3% of spleen lesions, 13.6% of the hepatic TB lesions and none of the pericardial TB lesions detected by ^{18}FDG. ^{68}Ga-citrate detected a similar number of lesions in the lungs and bones. However, ^{68}Ga-citrate detected more lesions in the brain with ^{18}F-FDG detecting only 60% of the lesions detected by ^{68}Ga-citrate. All the intracranial lesions showed a good response to anti-TB treatment with the mean change in SUV being-77.0% and-78.2% for ^{68}Ga-citrate and ^{18}F-FDG respectively ($p=0.9$). **Conclusion:** ^{68}Ga-citrate detected more intracranial TB lesions than ^{18}F-FDG and was found useful for follow-up of therapy. ^{68}Ga-citrate is similar or inferior to ^{18}F-FDG for detection of TB at other sites in the body.

High Resolution PET/CT with Digital Detectors – Cutting Edge of Nuclear Medicine?

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With introduction of PET/MR, signal readout from scintillation crystals was carried out for the first time with semiconductor detectors and no longer with classical photomultiplier tubes (PMT). This was necessary because only such photodiodes (silicon photomultipliers, SiPM) are compatible with magnetic fields. Although SiPM basically offers advantages over PMT, this first generation of digital detectors was not yet optimal, since it still required complex temperature stabilization and in particular showed a time resolution too poor to enable time of flight (TOF) PET. Since then, the semiconductor detectors have undergone extensive further development and their disadvantages compared to PMT have been eliminated. The latest generation of PET/CT devices is no longer based on PMT technology. Some of these systems have digital semiconductor detectors which allow a time of flight PET with previously unknown time resolution. Another advantage of these digital detectors is the possibility to have a scintillation crystal readout with a one-by-one or almost one-by-one coupling. This results in a better spatial signal separation, which leads to a better spatial resolution of these scanners. In combination with the improved TOF information these properties

in the measured raw data opens up the possibility of a data reconstruction with a higher resolution and larger image matrices. The use of small voxels (e. g. 2x2x2 mm^3 or even 1x1x1 mm^3) requires that sufficient counts per voxel have been acquired. Compared to the clinically commonly used voxel size in the image of 4x4x4 mm^3, the number of counts per voxel is reduced by a factor of 8 or 64. This reduced count statistic can be compensated to some extent by dedicated iterative algorithms (e. g. LOR-based TOF algorithms) which are capable of reconstructing data with very low counting statistics. Significant contrast improvements can be seen in such high-resolution images. Especially for small structures where the partial volume effect is very strong, contrast can be enhanced more than 50%.

The talk gives an insight into the technology of digital PET/CT scanners and presents the potential of these systems in clinical application by means of patient examples and more advanced analyses. The extent to which these improvements can be transferred into clinical routine and how these new possibilities make dedicated protocols for organ-specific acquisitions and reconstructions meaningful will become apparent in the coming years.

Oncology

Session 13: 10h35: Chairpersons: B Suchorska/J Warwick
PET: Response to Chemotherapy

J Buscombe[1]

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Though F-18 FDG PET has become a mainstay of imaging in oncology and been shown to be useful both in accurate staging or looking for recurrent disease what most oncologist also want to know is if there patients are responding to treatment and if possible some degree of prognostication.

In the late 1990s a group of haemotologists working out of Seattle made the observation that those patients who had a negative FDG PET after treatment had a much better prognosis than those with a FDG positive scan after treatment. This finding was confirmed by other observers and in a series of prospective trials run in the UK and Italy. In the late 1990s a group of nuclear medicine physicians lead by Sally Barrington and heamo-oncologist set up a meeting in Southern France. Understanding that comparing pre and post therapy scans may be difficult or impossible they set up a series of criteria which could be applied to an F-18 FDG PET scan 6 weeks after the end of their lymphoma treatment. This became the Deauville criteria and used the SUVmax at the site of known lymphoma and compared this to the liver and mediastinal (actually blood pool in the thoracic aorta) SUVmax on a 4 pint score. Though it is a simple method it has been robust and clinically useful and has also been recently applied to Hodgkin's disease and more interestingly in trying to predict outcome by re imaging after the 2nd or 3rd cycle of chemotherapy.

Using FGD PET in assessing the response to treatment of solid tumours has been more problematic. The best results have been the use of FDG to predict response of GISTS to imatinib where the drug disables the cancer cells hexokinase so responding patients are often FDG negative within 24 hours of treatment. Breast cancer has been more problematic as successful treatment often results in intense local inflammation at the tumour site so an increase in FDG may be due to tumour progression or tumour response. Some centres have tried to look at other agents such as F-18 FET to bypass this issue. Also there are no approved criteria as what to measure for response. Generally the Europeans tend to prefer looking at a tumour volume index where the volume of tumour is multiplied by FDG uptake using SUVmax or SUVmean. The Americans have tried to mirror the RESCIST criteria with PERCIST which uses a comparison of tumour to liver ratios but neither approach has gained any traction either clinically or in research.

PET/CT in Radiation Treatment Planning

W Oyen[1]

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FDG-PET/CT has become an important diagnostic tool in radiation oncology. Next to improved staging of patients potentially eligible for radiation treatment, the incorporation of molecular imaging findings into radiation treatment planning in common practice in e. g. lung cancer, head and neck cancer, prostate cancer, malignant lymphoma etc. Using molecular imaging for early prediction of response to radiation treatment may be one of the future strongholds of PET/CT to prevent prolonged, yet futile radiotherapy sessions in patients, who will ultimately not respond favorably.

After completion of radiotherapy, appropriate and adequate follow-up may be challenging. When patients have a high chance of local relapse, they may be advised to undergo additional surgery. However, post-radiotherapy resections can be considered overtreatment in patients who are cured by radiotherapy. Again, PET/CT may be helpful to select stratify between patients at risk for relapse and those who have achieved durable remissions. The role of molecular imaging in radiation oncology is increasing with the development of stereotactic body radiation therapy (SBRT), which very precisely delivers a high dose of radiation to the tumor while the tissues

around it only receive a low dose. For successful SBRT, early detection of disease relapse is crucial to allow treatment of truly oligometastatic disease, but preventing SBRT when metastases have become widespread.

PET/CT in Locally Advanced Cervix Cancer

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Departments of [1]Nuclear Medicine and [2]Radiation Oncology, Tygerberg Hospital, Stellenbosch University, Cape Town, South Africa

Cervix cancer remains a significant problem in women in developing countries including South Africa, who frequently present with locally advanced disease. In addition, these patients frequently present with comorbid HIV and TB infections.

Many patients with locally advanced cervix cancer are potential candidates for curative chemoradiotherapy. However given the associated treatment morbidity and the financial cost optimal patient selection is essential, particularly within the financial constraints of the state health service of a middle-income country.

Various approaches are utilised for the interpretation and further management of PET/CT findings that may be complicated by comorbid disease. Since its introduction in our institution PET/CT has been found to play a key role in the selection of patients for curative chemoradiotherapy. In these patients it further contributes to the radiation planning of both the primary tumour and para-aortic nodal disease. Despite these improvements to patient management there is evidence that the inclusion of PET/CT has resulted in a saving in the overall management cost.

The Value of AA-PET for Diagnostic, Prognostic and Therapy-Monitoring Purposes in Glioma

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Glioma constitute a heterogeneous group of primary brain tumors which are, despite of the improvement of diagnostic and therapeutic options over the last decade, associated with a dismal prognosis. Following the observation that presence or absence of certain molecular parameters such as MGMT promotor methylation, *IDH* gene mutation and co-deletion on chromosomes 1p/19q discerns different tumor entities, the revised World Health Organization (WHO) classification has implemented molecular markers into the histological diagnosis. So far, magnetic resonance imaging (MRI) remains the gold standard for initial diagnostic as well as post-therapeutic workup. However, reflecting the increasing understanding about molecular mechanisms of glioma biology, implementation of molecular imaging gains further importance for glioma patient management. In contrast to [^{18}F] FGD, which has limited use in neuro-oncology, amino-acid PET using the most widely available tracers [^{11}C] MET, [^{18}F] FET, and [^{18}F] DOPA has proven useful for diagnostic and therapy monitoring purposes. While differential diagnosis and evaluation of tumor progression using [^{11}C] MET and [^{18}F] DOPA is mostly confined to tumor-to-brain ratio analysis, [^{18}F] FET has been shown to provide a possibility for "dynamic" evaluation. Using a frame-based analysis of the [^{18}F] FET-uptake behavior over a defined period of time, additional information on tumor grade, vascularization and metabolic activity can be obtained. Dynamic analysis can be either performed by evaluating time activity curves (TACs) or time-to-peak (TTP) measurements. TACs can be either increasing or decreasing, depending on the speed of tracer uptake, while TTP refers to the time point of the tracer reaching its peak. While decreasing TACs and short TTP times are related to high grade de-novo tumors (WHO III and IV) as well as to malignant transformation, increasing TACs and long TTP times are mostly observed in newly diagnosed low grade glioma (WHO II) or therapy response. Furthermore, dynamic [^{18}F] FET-based evaluation has recently revealed prognostic information on disease course in de-novo glioma WHO II-IV which seems to be independent from WHO grading.

Milk Scans and How to Stay Out of Trouble

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- Criteria and normal values
- Clinical Indications
- Additional information
- Preparation
- Frightened, moving, screaming child
- Positioning.

Clinical

01
Puff of Smoke

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Introduction: Moyamoya Syndrome is a cerebrovascular condition that increases the risk of stroke in patients, through progressive stenosis of the intracranial internal carotid arteries and their proximal branches. Dilated collateral vessels appear cloud like or hazy on angiography hence the name "Puff of Smoke" – Moyamoya in Japanese. **Clinical Case:** A 41 year old congenital hearing impaired woman presented to the Emergency Department with left hemi paresis on a background of chronic migraines and borderline hypertension. Cerebral CT revealed impression of multifocal ischemic stroke. Additional imaging was performed – MRI, MRA (revealed significant right M1 of MCA, bilateral A1 stenosis with collateralisation) and Cerebral Angiogram that showed severe stenosis of the M1 segment of the right MCA with poor flow in the Sylvian branches. Tc99m HMPAO Baseline SPECT/CT revealed significant perfusion defect in the right frontal, parietal and superior portion of temporal cortices with correlative hypoperfusion in the right MCA and ACA territory. Acetazolamide intervention SPECT/CT revealed Acetazolamide induced impairment of cerebral blood flow reserve in the right MCA and ACA territory. Acetazolamide is a carbonic anhydrase inhibitor that acts as cerebral vasodilator. Ischemic tissue will demonstrate decreased uptake of radiopharmaceutical because of decreased vascular reserve relative to the normal spared brain parenchyma. Diagnosis was made of an acute stroke in the context of likely Moyamoya Syndrome. The patient was referred for EC-IC bypass surgery (Extra-Intra Cranial Bypass) that was successfully performed. 5 weeks post-surgery follow up imaging was performed. Tc99m HMPAO Baseline revealed interval improvement in the perfusion involving the right posterior frontal, frontoparietal and right superior temporal cortices – normal flow reserve post Acetazolamide infusion. Persistent hypo perfusion involving the right anterior frontal and right parietal cortices. Improvement of patient's symptoms was also seen – left hemi paresis became less severe to non-existent and the frequency and severity of her migraines decreased. Additional Neurostat processing was performed (software library for neurological and biochemical image analysis 3D-SSP using image-analysis software). Data on the brain surface perfusion extracted by 3D-SSP were compared. Spatial normalization, z-score 3DSSP was calculated by pixel-by-pixel comparison to reference database. These results confirmed the SPECT/CT findings. **Conclusion:** Nuclear Medicine imaging assisted in diagnosis and evaluating post cerebral bypass surgery.

02
Correlation of Prostate Specific Antigen with Metastatic Bone Disease in Prostate Cancer on Ga-68 PSMA PET/CT Scan

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Objectives: To define the correlation between serum PSA levels and Ga-68 PSMA in the prostatic cancer patients. **Methods:** Relationship between serum PSA kinetics with metastatic prostate cancer on Ga-68 PSMA PET/CT for staging/restaging for prostatic carcinoma in Sindh Institute of urology and transplantation, Department of molecular imaging were evaluated retrospectively. **Results:** Totally 29 patients included in the analysis. Mean age of patients was calculated as 68.2±7.6 (min-max: 51-88) years old. Ga-68 PSMA PET/CT indications were staging, restaging and response to treatment. Cut-off serum PSA level to predict Ga-68 PSMA PET positivity was calculated as 2.5.We calculated Serum PSA levels and Ga-68 PSMA positive and negative groups according to specified ranges i. e. >10 PSA the PPV was 60% vs. NPV 40%.<10 PSA the PPV was 38.4% vs. NPV 61.5%, > 5 PSA the PPV was 52.9% vs. NPV 47.0%. < 5 PSA PPV was 54.5% vs. NPV 45.4%, >2.5 PSA, PPV was 32.5% vs. NPV was 37.5%. <2.5 PSA, PPV was 47.8% and NPV was 52.1 % respectively. **Conclusion:** Serum PSA levels seems to correlate with Ga-68 PSMA PET/CT. Patients with PSA levels even less than 2.5 ng/ml would probably positive on Ga-68 PSMA PET/CT. In order to detect recurrent or metastatic disease at earlier stages more sensitive methods needed. After reviewing published articles of skeletal Scintigraphy with Tc-99m MDP we found that the serum PSA cut-off was 10ng/ml, while in our study with Ga-68 PSMA we found that even at low PSA i. e. <2.5 ng/ml, the positive predictive value was 47.8%. Ga-68 PSMA PET/CT is much more sensitive and specific as compared to other imaging modalities to investigate metastatic disease of prostate cancer.

03
The Usefulness of ^{18}F-DOPA PET Scans in Challenging Conditions at a Movement Disorder Clinic

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Background: Differentiating conditions characterized by degeneration of nigrostriatal pathways from secondary Parkinsonism or other tremulous/dystonic disorders may sometimes be difficult on clinical grounds, especially in the early stages of the disease, or atypical presentations. ^{18}F-DOPA PET scan is an investigation that can determine the degree of affectedness of presynaptic dopaminergic activity. The aim of this study was to determine the usefulness of ^{18}F-DOPA PET scan in challenging conditions at our movement disorder clinic. **Methods:** A retrospective analysis was carried out for patients that underwent ^{18}F-DOPA PET brain scans between 2016-2017. The patients' medical records were assessed for asymmetry of symptoms, course of illness and length of follow-up. ^{18}F-DOPA PET scans were requested when there was uncertainty about the clinical diagnosis. Qualitative interpretation of the scan was performed based on the visual assessment of the uptake in the basal ganglia. A scan was considered abnormal when the visual assessment revealed a relative decrease in ^{18}F-DOPA uptake in the striatum. The final clinical outcome was based on progression at follow-up and response to levodopa or other medications such as primidone. A correlation of the scan findings with the final clinical outcome was performed using statistical agreement test. **Results:** Twenty-four patients were included (mean age, 57.7 years; 13 men, 11 women, mean follow up 13 months). Of the 24 scans, eight scans were reported as normal, while 16 scans were reported as abnormal. There was a good agreement between the scan results and the final clinical outcome (kappa = 0.80). The scans were normal in essential tremor cases, dystonic tremor and drug induced Parkinsonism. We also noted that patients with atypical akinetic-rigid Parkinsonism had cognitive impairment and abnormalities in both putamen and caudate nuclei, whereas tremor dominant Parkinson's patients had abnormalities restricted to the putamen with no cognitive impairment. **Conclusion:** When there is uncertainty about the diagnosis, ^{18}F-DOPA PET scan is a useful investigation to differentiate conditions due to nigrostriatal degeneration from those with overlapping clinical presentations.

04
The Conclusions Drawn from Ventilation/Perfusion Single Photon Emission Computed Tomography Compared to Lung Perfusion Single Photon Emission Computed Tomography and a Chest X-Ray in Patients with Suspected Pulmonary Thromboembolism

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Purpose: There are conflicting results from studies on whether the ventilation (V) scintigraphy can be safely omitted or replaced by a chest x-ray. These studies were based on planar ventilation perfusion (V/Q) scintigraphy. We evaluated the value of the V single photon emission computed tomography (SPECT) on the final conclusion drawn from a V/Q SPECT and the possible role of the chest x-ray as a surrogate for the V SPECT. **Methods:** Raw data of V/Q SPECT images and chest x-ray acquired within 48 hours over 18 months period were retrieved, reprocessed and reviewed in batches. The V SPECT, Q SPECT and chest x-ray were reviewed separately and in combination. Data on the presence and character of defects and chest x-ray abnormalities were recorded. The V/Q SPECT images were interpreted using the criteria in the EANM guideline and the Q SPECT and chest x-ray images were interpreted using the PISAPED criteria. Agreement between the diagnosis on the V/Q SPECT review and the Q SPECT and chest x-ray review was analysed. **Results:** 21.1% of the patients were classified as 'PE present' on the V/Q SPECT review whereas 48.9% were classified as 'PE present' on the Q SPECT and chest x-ray review. Only 5.4% of defects seen on V SPECT had matched chest x-ray lung field opacity. **Conclusion:** Our study showed that the omission of a V SPECT led to a high rate of false positive diagnoses and that the ventilation scan cannot be replaced by a chest x-ray.

05
Imaging of a Rare Case of Small Cell Neuroendocrine Tumour of the Vulva

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Background: Neuroendocrine tumours (NETs) are a heterogenous group of tumours arising from enterochromaffin cells located in neuroendocrine tissues throughout the body. The most common sites of NETs are the gastrointestinal tract, pancreas and respiratory tract. In the female reproductive tract NETs are rare, accounting for 2% of gynecologic tumours with the ovary being the most common site. The vulva is an uncommon site for NETs with only few cases reported in the literature till date. WHO classifies vulvar NETs into high-grade neuroendocrine carcinoma (small cell and large cell variants) and Merkel cell tumour. Our literature

search revealed <20 cases of Merkel cell carcinoma and a single case of small cell neuroendocrine carcinoma. **Aim:** To demonstrate the rare case of neuroendocrine carcinoma of the vulva and highlight the ideal choice of radiotracer for molecular imaging. **Methods:** We report the case of a 27year old female referred for PET/CT imaging for staging of a primary neuroendocrine tumour of the vulva diagnosed from biopsy of a left vulva mass. Based on the available literature, a low grade tumour subtype was suspected and 68Ga-DOTATATE PET/CT imaging was done. This revealed a left vulva mass with pelvic lymph nodes (Fig 1a, b) demonstrating mild tracer uptake (Krenning score=1). A review of the histology revealed a high grade, small cell neuroendocrine carcinoma of the vulva. Subsequent PET/CT imaging with 18F-FDG done one week later showed more intense in homogenous uptake with central necrosis in the vulva tumour (SUV=24.32). Pelvic lymph nodes also demonstrated intense FDG uptake (highest SUV=11.30) (Fig 2a, b). **Conclusion:** This rare case emphasizes the choice and role of 18F-FDG in lieu of DOTA-peptides imaging in high grade neuroendocrine carcinoma.

06
Efficacy of Single Fixed dose Radioiodine (I-131) Therapy in Patients with Hyperthyroidism at Groote Schuur Hospital

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Aim: To find out what percentage of patients receiving I-131 therapy was the treatment successful? In which patients was the treatment not successful and a second dose needed? And what factors could be responsible for the treatment failure? **Methods:** A single observer is reviewing all the I-131 therapy for hyperthyroidism from 23 April 2010 to 23 November 2017 in conjunction with pre and post treatment thyroid function tests, thyroid ultrasound and TC-99m Pertechnetate thyroid scintigraphy. **Preliminary Result:** Preliminary results till date showed that within the period under review, 23 April 2010 to 23 November 2017, 467 doses of radioiodine was administered. Out of this figure 396 meet all the inclusion criteria. These 396 therapies were administered to 371 patients for the first time while the remaining 25 patients received more than dose. Out of this 371 patients 301(84.7%) achieved cure at some stage. Of this figure, 255(84.7.3%) patients achieved cure after first dose while 46(15.3%) achieved cure after more than one dose of radioiodine therapy. Seventy patients did not achieved after first dose and six patients did not achieve cure after more than one dose of radioiodine. Early results also indicated high pre-treatment heart rate, high pre-treatment FT4, lower pre-treatment TSH and high percentage uptake of ^{99m} Tc – pertechnatate could predict failure of first fixed dose of radioiodine therapy. **Preliminary Conclusion:** Failure rate for first time of fixed dose of I-131 therapy for thyrotoxicosis in our institution is similar to that reported in literature.

07
^{99}mTc MAG3 Scintigraphy in a Patient with Hyperacute Antibody Mediated Rejection: A Description of the Correlation between Image Findings and Clinical Disease Process

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Background: Hyperacute antibody mediated rejection (HA-AMR) occurs within 24 hours after a renal transplant. Technetium-99m Mercaproacetyl triglicine (^{99m}MAG3) scintigraphy is rarely done within this time period and clinicians rely on clinical features and laboratory parameters for diagnosis. To date literature reports on the correlation between clinical features, laboratory parameters and ^{99m}Tc MAG3 scintigraphy in patients with HA-AMR is sparce. **Aim:** Describe the scintigraphic features on serial ^{99m}MAG3 renograms together with the clinical and laboratory findings at diagnosis and during treatment of a patient with HA-AMR. **Methods:** Four ^{99m}Tc MAG3 renograms performed on days 1, 4, 11 and 66 post transplant were reviewed. Clinical and laboratory parameters (serum creatinine and urine output) were also evaluated during these time points. **Results:** Patient was transplanted at 11am. Overnight patient was clinically well, urine output was 5500mL and creatinine decreased from 866umol/L to 795umol/L. ^{99m}Tc MAG3 renogram however showed markedly delayed and decreased perfusion with poor uptake and cortical defects. Renogram grade (RG),as described by Heaf et al, was 4. Patient was taken back to theatre to exclude vascular pathology. No thrombus was found, however infarcted areas on the surface of the kidney were seen. Patient was commenced on treatment for HA-AMR. On day 4 post transplant and day 3 after initiation of antirejection therapy, urine output decreased to 850mL/d and creatinine increased to 955umol/L. Another ^{99m}Tc MAG3 renogram was performed which showed improved perfusion and uptake as well as significant I mprovement in the cortical defects. On day 11 post transplant the patients creatinine decreased to 635umol/L and urine output increased to 1030mL/d.

^{99m}Tc MAG3 renogram showed a further improvement in perfusion, uptake and cortical defects. The patient was discharged on day 15 post transplant with a creatinine of 425umol/L. She continued to do well and on day 66 post transplant her creatinine was 246umol/L. ^{99m}Tc MAG3 renogram at this stage also showed a further improvement in perfusion, uptake and cortical defects. Renogram grade at discharge was 1. **Conclusion:** ^{99m}Tc MAG3 scintigraphy is recommended for baseline renal function within 24 hours after renal transplant. Clinical parameters may take several days before they a representative of an underlying pathological process. ^{99m}Tc MAG3 scintigraphic features correlate with underlying disease process and outcome.

08
Benefits of Sentinel Lymph Node Mapping in Recurrent Breast Cancer

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Introduction: Axillary node status is a major prognostic factor in early breast cancer. Traditional staging requires axillary lymph node dissection. Staging with sentinel lymph node biopsy (SLN biopsy) leads to substantial reduction in surgical morbidity and it is important in tailoring of the treatment. **Subject:** A 57yr old female with clinical history of prophylactic right mastectomy and reconstruction surgery 5 years ago. Now presenting with a malignant tumor in the right medial breast, approximately 3 to 5 o'clock location. **Method:** 3 intradermal injections of Tc99m-nanocolloid (1mCi) were administered over the tumor lesion in the right breast. Fig.1 20min dynamic series demonstrate lymphatic drainage from the primary lesion in the right medial breast along the left anterior chest wall into the left axilla. Fig 2 intense uptake in 2 lymph nodes in the left axilla. Fig 3 Delayed 1 hr images demonstrated well-defined nodes in the left axila. **Discussion:** SLN biopsy is not routinely performed in a recurrent breast cancer. It is believed that mastectomy precludes the subsequent option of SLN biopsy in case an unsuspected carcinoma is found. A total axillary node clearance of the affected side is standard procedure without considering the possibility of spread into the opposite side. This case confirms that previous breast surgery is not a contraindication for SLN biopsy. SLN biopsy creates wider perspective to the possibility of the drainage moving into the opposite side or other lymphatic basins instead of the expected drainage site, if the tumor were in the intact quadrant of the breast. The lymph nodes dissected from the patient's opposite (Left) side were positive for cancer cells with the largest lymph node being completely replace by tumor. The lymph nodes dissected from the ipsilateral (Right) axilla showed no evidence of malignancy in any of the sections examined. **Conclusion:** Previous breast surgery should not be used as an exclusion criterion for performing SLN biopsy. This case demonstrates that the lymphatic drainage may not always follow the expected path. Lymphoscintigraphy can easily identify atypical drainage patterns.

09
Does Somatostatin Receptor Positive Tumor Volume Determined on ^{68}Ga DOTANOC PET/CT in Patients with Paraganglioma/ Pheochromocytoma Correlate with Biomarkers? An Explorative Study

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Background: Somatostatin receptor (SSR) imaging with ^{68}Gallium DOTA PET/CT is used in workup of pts with Pheochromocytoma (PCC) and Paraganglioma (PGL). Correlation of tumour burden on ^{68}Gallium DOTA PET/CT and biomarkers, 24 hr Urine Metanephrines (UMET), normetanephrine (UNMET), UMET: creatinine ratio (MET: Crea),UNMET: creatinine (UNMET: crea) and Chromogranin A (CGA) has not been done. **Aim:** Correlate tumour burden on ^{68}Ga DOTANOC PET/CT with biomarkers UMET, UNMET, MET: crea, UNMET: crea and CGA. **Methods:** Since September 2015 data of pts with PGL/PCC at Groote Schuur scanned with ^{68}Ga DOTANOC PET/CT has been analyzed. Biomarkers done at the time of imaging or as close as possible to the imaging date have been recorded. On ^{68}Ga DOTANOC PET/CT peak standardized uptake value (SUVpeak), metabolic tumor volume (MTV) & total lesion SSR burden (product of mean SUVpeak x MTV) hitherto named TLSSRB were evaluated. **Results:** To date 22 pts (mean age 40; female: male 16:6) have been imaged. 20 pts: had histologically confirmed PGL/PCC and 2 pts were clinically confirmed. Primary tumour locations were: extra adrenal (13) adrenal (9). Malignant histological features seen on histology in 2/20pts, benign histological features seen in 18/20pts. All patients with malignant features on histology had metastases on ^{68}Ga DOTANOC PET/CT, 11/18 (61.1%) with benign features on histology had metastases. Locations of metastases were: bone (62%), Lymph nodes (23%), visceral (85%). Median value of the biomarkers: CgA 320 IQR (217.9; 982.9),UMET 1075 IQR(402.5;4243.0),

UNMET 3999.0 IQR (1440.8;27978),UMET: crea 75 IQR (42.3;312) UNMET: crea 428.5 IQR(180;3205.5). Significant correlation seen between MTV and UMET (spearmans correlation; p=0.046) TLSSRB tended to show a correlation with UMET (spearmans correlation; p=0.061). Rest of biomarkers did not show correlation with ^{68}Ga DOTANOC PET/CT parameters. **Conclusion:** Our data thus far shows that total body tumor burden measured on ^{68}Ga DOTANOC PET/CT correlates with UMET. Histology cannot be reliably used for absence or presence of metastases as up to 61% of "benign" PGL/PCC can show metastatic disease on ^{68}Ga DOTANOC PET/CT.

10
Changing the Workplace Learning Environment for Registrars: Piloting a Competency-Based Formative Assessment Program

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Background: Without guidance on their progress along the path to competence, registrars can be unsure of expectations and progress, assessment by consultants, unsystematic. No workplace-based formative assessment program for Nuclear Medicine exists in South Africa currently. **Aim:** To review a workplace-based formative assessment program which was designed and implemented in the Department of Nuclear Medicine, University of Cape Town. **Methods:** Competencies were adapted for Nuclear Medicine from the CanMEDS 2015 competency framework and milestones developed for different levels of training. The Mini-CEX tool was adapted for scoring and feedback provision in Google Docs on smartphones. After a six-month pilot, interviews were conducted with registrars and consultants and thematic analysis undertaken. Feedback was analysed using Pelgrim's et al's (2012) framework. **Results:** 91 assessments (3 consultants, 4 registrars) were conducted. The most frequently assessed core competency was Medical Expert. Feedback was only provided in 70/91 interactions with little feedback from one consultant. 86% of feedback was specific. Interviews revealed that interaction with and understanding of the CanMEDS framework and milestones was lacking. Reasons included difficulties in understanding terminology, applicability to the specialty and setting as well as unfamiliarity. Registrars felt that their learning was enhanced, but factors such as inherent motivation, level of training, culture and environment affected the magnitude thereof. For consultants, the approach provided a structured, robust, objective way of collecting performance data. While none of the participants felt that workflow was disrupted, everyone found the use of a smartphone awkward and artificial. **Conclusions:** Despite contextual adaptation and buy-in, the integration of a competency-based framework and feedback program in our setting was challenging. Each aspect of the program had unique local factors affecting overall vigor. Other NM Departments in SA are keen to adopt this approach, but such rollout will require careful planning and local contextualisation. Competency based programs need to be designed individually for the environments in which they are going to be applied.

11
^{18}F-FDG PET-CT May Play a Crucial Role in the Imaging of Patients with Burkitt's Lymphoma and Suspected Leptomeningeal Involvement

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Background: Burkitts lymphoma (BL) is a type of Non-Hodgkins Lymphoma affecting B cells. Epidemiologically, it is divided into 3 subtypes, with the AIDS-related subtype manifesting more with extranodal disease including involvement of the central nervous system (CNS). Clinical features include confusion, seizures, headaches and cranial nerve palsies. Involvement of the CNS is classified as stage IV disease and has a poorer prognosis. Only a small fraction of patients with CNS disease will demonstrate cytologically detectable malignant cells in the cerebrospinal fluid (CSF). Although cytology of the CSF is the diagnostic gold standard, it has a low sensitivity with a false negative rate as high as 60%. Recent studies reveal that CSF flow cytometry may be more sensitive than cytology and thus better able to detect occult disease. ^{18}F-FDG PET-CT has rarely been performed for this indication. **Aim:** The aim was to assess the usefulness of ^{18}F-FDG PET-CT imaging to detect leptomeningeal involvement in a patient with Burkitt's lymphoma. **Method:** A 36-year-old HIV-positive female patient with Burkitt's lymphoma of the right atrium developed cranial nerve palsies. ^{18}F-FDG PET-CT imaging was performed to evaluate the extent of disease, and the results compared with other investigations to confirm leptomeningeal involvement. **Results:** ^{18}F-FDG PET-CT confirmed florid intracranial and leptomeningeal disease. Lumbar puncture was performed and immunophenotypic analysis confirmed leptomeningeal involvement with 85% CD10/CD19 co-expressing cells. In addition, PCR analysis for the IgH gene rearrangement was positive.

After one cycle of chemotherapy, intrathecal therapy and cranial irradiation, there was clinical improvement in the cranial nerve palsies. A follow-up ^{18}F-FDG PET-CT will be performed after the full treatment to more thoroughly evaluate response. **Conclusion:** ^{18}F-FDG PET-CT may be a very useful imaging modality to confirm leptomeningeal in patients with Burkitt's lymphoma in settings where immunophenotypic and PCR analyses are not readily available. It may also be used to monitor response to treatment. To the best of our knowledge, very few cases have been reported in the literature using ^{18}F-FDG PET-CT for this indication.

12
Using [^{68}Ga]PSMA-11-PET/CT Imaging to Study Glutamate Carboxypeptidase II in Breast Cancer Bearing Animal Models

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Background/Aim: Breast cancer is the most prevailing malignancy leading to cancer related death in women worldwide. Estrogen receptor positive breast cancer is sensitive to hormonal therapy. However challenges present post-therapy were some metastatic tumor sites present with different hormone receptor expression in comparison from the primary tumor. This could lead to resistance against the selected therapy due to heterogeneous metastatic tumor sites differing from the primary breast cancer cells. It has been reported; advance stages of breast cancer be visualized by [^{68}Ga] Glu-urea-Lys (Ahx) $^{HBED-CC}$ ([^{68}Ga] PSMA-11)-positron emission tomography/computed tomography imaging. Through better understanding of the molecular mechanism responsible for the [^{68}Ga]PSMA-11 uptake by breast cancer cells this tracer could offer an alternative approach to the standard [^{18}F]FDG diagnostic and would impact current peptide receptor radioligand therapies. This study seeks to understand the pathological uptake of [^{68}Ga] PSMA-11 in breast cancer and its relation to the expression of glutamate carboxypeptidase II. **Methods:** Female athymic mice xenograft bearing either MCF-7/MDA-MB-231 human breast cancer cells will be compared with LNCap human prostate cancer (positive control) and EA-hy926 human endothelium-derived (negative control) xenografts. For safe administration of [^{68}Ga]PSMA-11 into mice a suitable radiolabeling procedure was established amending parameters such as buffering agent, PSMA specific activity and osmolality of the tracer formulation. All animals will undergo sequential microPET/CT imaging of [^{18}F] FDG (reference scan) and [^{68}Ga] PSMA-11 within 48 h. **Results:** The growth of MCF-7 and MDA-MB-231 were demonstrated *in vitro*/*in vivo*. A purity of 95-100% of [^{68}Ga] PSMA-11 was obtained by adding 1 ml radioactivity fraction of $^{68}GaCl_3$ (0.6 M HCL) from ^{68}Ge/^{68}Ga generator into 5 nmol PSMA-11.[^{68}Ga]PSMA-11 was successfully labelled in the presence of sodium acetate (not HEPES) at pH 4-4.5. The specific activity was 0.25-0.28 GBq/nmol; the activity concentration was significantly increased up to 1.02-1.12 GBq/ml (P <0.05) by performing a solid phase extraction procedure using C18-cartridge matrix.[^{68}Ga] PSMA-11 was recovered in 0.25-0.60 ml 50% ethanolic saline followed by solvent evaporation. The final formulation for preclinical application included sterile filtration and an optimized activity concentration (320-455 MBq/ml non-decay corrected, pH6.5-7). Animal experiments requiring [^{68}Ga] PSMA-11 concentrations of 10.0-12.5 MBq/0.15 ml will be warranted with up to 3 tracer administrations within 120 min from a single [^{68}Ga] PSMA-11 radiosynthesis. **Conclusion:** Optimal radiolabeling protocol for the safe administration of [^{68}Ga] PSMA-11 into small animals was successfully developed. Breast cancer lines and their xenograft preparation using nude mice as well as the parameter for the PET/CT imaging acquisition were successfully studied.

13
^{18}FDG PET/CT Role in the Recurrence of Human Epidermal Growth Factor 2 Positive Invasive Ductal Carcinoma of the Breast

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Background: The risk factors for breast cancer outcome are multiple and are considered in determining the treatment options for this malignancy. The hormone receptors and human epidermal growth factor 2 (HER-2) status of these cancers have been demonstrated to influence the rate and pattern of recurrence. HER-2 positive breast cancer has a lower incidence compared to HER-2 negative tumours, however it has been found to be associated with more aggressive disease with a higher risk of recurrence. **Aim:** The aim of this study is to demonstrate the role of Flourine-18 Flourodeoxyglucose Positron Emission Tomography/Computer Tomography (F-18 FDG PET/CT) in determining the rate and extent

of recurrence in HER-2 positive versus HER-2 negative invasive ductal breast carcinoma (IDC). **Methods:** We evaluated F-18 FDG PET/CT scans of IDC breast cancer patients referred for evaluation of recurrence since 2009 to date. Imaging of these patients was done using the standard departmental protocol followed at our institution. The number of sites of metastases were calculated for the HER-2 positive and negative groups. The highest standard uptake value (SUVmax) was calculated to determine the highest metabolic avidity of the tumours in the respective groups. Statistical analysis was done using the T-test calculator. **Results:** A total of 46 (n=46) IDC breast cancer patients with a mean age of 56.58±12.46 years referred for recurrence were studied. Two patients were excluded due to incomplete data. Of the remaining sample, 28 patients were HER-2 negative and 16 patient's HER-2 positive. In the HER-2 positive group, 31% of patients demonstrated local recurrence on F-18 FDG PET/CT with or without distant metastases versus 28% in the HER-2 negative group. The total number of sites of recurrence did not demonstrate statistical significance in the HER-2 positive versus negative groups (29 versus 46 respectively, p = 0.288). The highest SUVmax also demonstrated a statistically insignificant difference between the two groups (206, 99 versus 280, 17 in the HER-2 positive versus negative groups respectively, p= 0.34). **Conclusion:** F-18 FDG PET/CT was not able to show a statistically significant difference in the rate and extent of recurrence between HER-2 positive and negative IDC breast cancer patients. Therefore as a single independent variable, the HER-2 status of the patients with IDC breast cancer may not be a good predictor of disease recurrence demonstrable on F-18 FDG PET/CT as evident in this study.

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The Complimentary Role of 18F FDG PET/CT and Serum Tumour Makers in Recurrent Breast Cancer at Steve Biko Academic Hospital: A Retrospective Study

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Introduction: Breast cancer is a commonly diagnosed cancer and one of the leading causes of death worldwide. Patients with breast cancer who undergo mastectomy or breast conserving therapy are at risk of locoregional recurrence or metastatic disease. The recurrence rate for these therapies is 5 and 7 percent respectively. The current NCCN guidelines recommend follow up with mammography following curative therapy but this is not without limitations. Currently, there are no randomised clinical trials to evaluate the effectiveness of MRI, ultrasound and PET/CT in breast cancer surveillance. Serum tumour makers, such as CA 15-3, CEA, CA 19-9, LDH and CA 27.29 are useful in the detection of early recurrence of breast cancer. These have been shown to be sensitive, however nonspecific. **Aim:** To correlate FDG finding (using SUV max) with serum tumour markers in breast cancer recurrence. **Method:** 73 patients with breast cancer that presented to the nuclear medicine department between 2009 and 2018 for an FDG PET/CT with suspected breast cancer recurrence were identified. Patients with serum tumour markers older than 3 months before or after the FDG PET/CT were excluded. 25 patients comprising of 24 females and 1 male with an average age of 53 were shortlisted. The histology of the primary, disease distribution, the SUV max of the most intense lesion and serum tumour markers (CEA, CA125, CA15-3 and CA19-9) were recorded from patients' files and NHLS. **Results:** 14 of the 25 patients had elevated tumour markers. 5 of these with an average SUV max of 11.9 had more than 3 sites of disease involvement, 2 with an average SUV max of 8.16 had 2 sites of disease involvement, 3 patients with an average SUV max of 3.05 with one site of disease involvement and 3 patients with no region of tracer uptake. 11 patients had normal level of serum tumour makers. 3 of these had an average SUV max of 14.92 had more than 3 sites of disease involvement, 1 with an SUV max of 3.79 with 2 sites of disease involvement, 1 with an SUV max of 2.6 with one site of disease involvement and 5 with no site disease involvement. **Conclusion:** Although FGD PET/CT may not be recommended in the routine follow up patients with breast cancer, it's utility may be valuable in patients with elevated serum tumour markers or with suggestive clinical symptoms and physical findings with equivocal conventional imaging studies.

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Patterns of ^{18}F-FDG Uptake in HIV Positive Patients with Vulva Cancer

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Background: Vulva cancer is the fourth most common gynaecological malignancy and accounts for 5% of all malignancies of the female genital tract. Furthermore, HIV infected women are at increased risk of developing vulvar cancer. **Aim:** The aim of our study is to evaluate the effect of HIV infection on the PET/CT metabolic parameters and metastatic patterns in patients with vulva carcinoma. **Methods:** We evaluated 26 HIV-seropositive and 16 HIV-seronegative patients for initial staging and suspected recurrent vulva carcinoma using F-18 FDG PET/CT. The PET/CT datasets were

interpreted by two independent readers blinded to the HIV status of the patients. Areas of disagreement were resolved by consensus. **Results:** HIV-positive patients were 24 years younger than the HIV-negative patients at the time of diagnosis; mean age 40 years versus 64 years respectively. There was no significant difference in the time to recurrence in HIV-infected compared with HIV-uninfected women (19 versus 21 months). The commonest sites of metastatic recurrence were in distal lymph nodes, liver and lungs in HIV patients. SUV max values in HIV positive patients are higher (mean SUV max 55.11) than in HIV negative patients (mean SUV max 8.11). **Conclusion:** HIV-positive patients are younger than HIV-negative patients at initial diagnosis, and have distant sites of metastasis at recurrence. In addition, SUVmax was significantly higher in HIV-positive patients when compared with HIV-negative patients.

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^{18}F-FDG PET/CT and Sentinel Lymph Node Biopsy in Patients with Early Stage Cervical Cancer

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Background: Cervical cancer is staged clinically using the International Federation of Gynaecology and Obstetrics (FIGO) staging system. Although lymph node status does not form part of the staging, it has important prognostic and potential therapeutic implications. Complications following pelvic lymphadenectomy include lymphocysts and lymphoedema of the lower limbs. **Aim:** To evaluate the role of PET/CT in detecting lymph node metastases in patients with early stage cervical cancer taking the histopathological results of the sentinel lymph node (SLN) and lymphadenectomy as the reference. **Methods:** Twenty-two patients with early stage cervical cancer were prospectively studied. They had a pre-operative ^{18}F-FDG PET/CT, SLN mapping using 99mTechnetium-labelled nanocolloid and blue dye followed by a radical hysterectomy and pelvic lymphadenectomy. The PET/CT findings were compared to histopathological results. **Results:** The histopathological results revealed lymphatic metastases in 4 patients. PET/CT revealed hypermetabolic nodes in 6 of the patients. Three of these had metastases. The other 3 cases were regarded as false positives as no metastases were noted histologically. One patient who had a negative PET/CT had metastases in the SLN biopsy. The overall patient-based sensitivity, specificity, positive and negative predictive values and accuracy of PET/CT in the detection of lymphatic metastases were 16.7%, 83.3%, 50%, 93.8% and 81.8% respectively. **Conclusion:** The sensitivity of PET/CT in the lymph node staging of early stage cervical cancer is low and can therefore not replace SLN biopsy. The specificity and negative predictive value are however high and can be used in conjunction with SLN biopsy.

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Renal Cortical Transit Time as a Predictor for Pyeloplasty in Paediatric Patients with Unilateral Hydronephrosis at the Red Cross War Memorial Children's Hospital

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Background: Majority of patients with unilateral hydronephrosis (HN) detected on ultrasound do not require pyeloplasty. Indications for pyeloplasty are in patients with symptomatic obstruction (recurrent flank pain), complications such as a UTI, a drop in DRF of more than 10% and a progressive increase in the APD in subsequent studies. Schlotmann, Piepsz and Harper et al have demonstrated the measurement of the cortical transit time (CTT) to predict the need for patient who may require pyeloplasty. **Aim:** To assess if the CTT would have predicted a drop in DRF in patients with unilateral HN on the affected side. In addition to assess whether the CTT would differ on the first renogram between those patients who had a pyeloplasty and those who did not have a pyeloplasty. **Methods:** Sixty eight patients with at least two renograms with unilateral HN with a normal contralateral kidney were observed retrospectively between December 2000 and May 2015. The CTT was recorded for the upper, middle and lower third of each kidney and the mean used as the CTT of the kidney. Each renogram was processed three times to measure the DRF using the Rutland Patlak and Integral methods. The mean of the three DRF measurements was used for analysis. **Results:** The mean CTT of the left and right hydronephrotic kidneys were 6.0minutes and 6.7minutes respectively. A significant relationship was demonstrated in the CTT and DRF as well as CTT and APD in the first renogram of those patients who did not have a pyeloplasty ($p < 0.05$). There was no difference between the DRF of the first and second renograms in those patients who did not have a pyeloplasty. In the 20 patients who had a pyeloplasty, there was a drop of more than 10% in the DRF of 3 patients. No difference was seen in DRF or in the CTT between the first and second renogram. The CTT was shorter in the second renogram in 9 of the 20 patients who had a pyeloplasty. No significant difference was

found in CTT or DRF when comparing the group who had surgery against the group who did not have surgery. **Conclusion:** The current study was unable to demonstrate in our series of patients that CTT can predict those patients who would require pyeloplasty. This may be owing to the retrospective nature of the study and reliance on clinical notes for the ultrasound data and surgical notes.

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Comparative Analysis: Cost, Efficacy, Progression Free Survival of ^{131}I MIBG versus ^{177}Lu DOTATATE Therapy in Metastatic Paraganglioma: A Case Report

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Introduction: Apart from surgery for localized disease, treatment options for patients with metastatic paraganglioma is limited. Targeted radionuclide therapy with ^{131}I MIBG has for a long time been considered as first line therapy. Over the past decade (Peptide Radionuclide Receptor targeted) PRRT therapy with ^{177}Lutetium DOTATATE has become available and has shown good results with improved overall and progression free survival (PFS), low hematotoxicity and a favourable radiation safety profile. Unfortunately the biggest drawback of PRRT is cost, particularly in the public sector in South Africa. **Method:** A comparative analysis evaluating cost, efficacy and progression free survival in a patient diagnosed with a metastatic bladder paraganglioma treated with ^{131}I-MIBG and PRRT at Groote Schuur Hospital was done. **Results:** 33-year-old male presented in 2012 with a bladder paraganglioma, Ki 67 =2%. After primary resection he was lost to follow up and represented 4 years later with recurrence (confirmed on ^{68}Gallium DOTANOC PET CT) and uncontrolled hypertension which resulted in a cerebro vascular accident (CVA). Due to cost concerns a decision was made to treat him with 5.5GBq of ^{131}I-MIBG. Uptake of ^{123}I MIBG on the diagnostic scan was concordant to the uptake seen on ^{68}Gallium DOTANOC PET CT. ^{131}I MIBG Baseline: Urine metanephrine (UMET) = 5400, normetanephrine (UNMET) =94800, Metanephrine creatinine ratio (UMET: creat) =273, Normetanephrine creatinine ratio (UNMET: creat) = 4788, Chromogranin a (CGA) = 1482. Blood pressure (BP) controlled on 4 agents. Follow up 4 months post ^{131}I MIBG UMET = 1800, UNMET =39900, UMET: creat = 273; UNMET: creat =6045, CGA =1798. BP controlled on 4 agents but higher doses. Progression of disease seen on follow up ^{68}Gallium DOTANOC PET CT Cost analysis: ^{131}I MIBG (Isotope; 11 days admission for alpha blockade and therapy, biochemistry) =R58000.
PFS = 4 months
PRRT
Baseline: UMET= 7200, UNMET= 124200, UMET: creat=400, UNMET: creat = 6900, CGA = 2579. Blood pressure (BP) still controlled on 4 agents at high dose.
Follow up 3 months post PRRT: UMET = 6664, UNMET =87346, UMET: creat = 483; UNMET: creat =6328, CGA =2007. BP controlled on 4 agents but doses reduced.
Cost analysis PRRT (Isotope; aminosteril infusion, 4 days admission for alpha blockade and therapy, biochemistry, ^{99m}Tc MAG3, ^{51}CrEDTA GFR) = R64000.
PFS = not reached.
Conclusion: In our patient PRRT resulted in improved outcome as measured by biochemical response, BP control and PFS when compared to ^{131}I MIBG. The difference in cost was only 10%.

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The Frequency of Appendicular Metastatic Lesions within the Skeleton in Patients with Carcinoma of the Prostate

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Background: Prostate cancer (PCa) is one of the leading malignant diseases in men and the skeleton is a common site of metastases. The axial skeleton (spine) is known to be the most common site of skeletal metastasis. **Aim:** The aim of the study was to evaluate the frequency of appendicular metastases in patients with known PCa irrespective of preoperative/postoperative status, presenting for bone scan at our department. **Methods:** A retrospective study on 627 PCa patients who had a bone scan was done over the period of 12 months (from Jan 2017 to Dec 2017). The findings in the skeleton were recorded and analysed for the site of metastases. Other parameters that were evaluated were serum prostate-specific antigen (PSA), Gleason score (GS) and indication for the scan. **Results:** We had a total of 626 patients that had Tc99m Methylene-diphosphonate scan. The age range was 49 to 90 years. The indication for the scan was staging (96%) and restaging (4%). There were 19% of patients that had axial metastases, versus 15% of patients with appendicular metastases. Of the patients that had appendicular metastases, 91% had axial metastases. The most frequent site of appendicular metastases was the pelvis (4%), and femur (2%). The frequency of appendicular metastases was highest in patients with high grade Gleason and a PSA of >20ng/mL. **Conclusion:** The axial skeleton is the most common site for metastases in PCa. In peripheral metastases, the pelvis and femur are more commonly involved. There were no patients with metastases below the femur, and

in a busy nuclear medicine department, imaging up to the midshaft of the femur is sufficient for an adequate scan report.

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Progressive Accumulation of Radiolabeled White Cells in Scans Performed for Suspected Vascular Prosthetic Graft Infections

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Background: Vascular graft infection is a serious complication which can be diagnosed using radiolabeled white cell scintigraphy (WCS). In a recent scan performed for suspected vascular graft infection (SVGI) in our department, increased white cell accumulation around the graft had cleared by 24 hours. Interpretation criteria proposed by a recent multicenter study would have incorrectly classified this scan as negative for infection. Importantly, participants in that study did not include any patients with SVGI. No research has to date investigated whether assessment of progressive white cell accumulation improves the accuracy of WCS performed for SVGI. **Aim:** To determine whether visual and semi-quantitative measures of white cell accumulation up until 24 hours improve accuracy of WCS performed for SVGI. **Methods:** A retrospective analysis was performed of all WCS scans performed for SVGI between January 2004 and March 2018. Studies were only included if both 3-hr and 24-hr imaging were available. Initial 3-hr images were first classified as positive or negative on the basis of presence or absence of white cell activity at the site of the vascular graft. Next, by comparing 24-hr and 3-hr images, studies were scored as either positive or negative based on the presence or absence of progressive white cell accumulation: both visually, and by calculating an accumulation index using suitable regions of interest with count values corrected for decay. A composite reference standard upon which the final diagnosis was made was based on a combination of microbiological, clinical and imaging follow up. **Results:** Provisional analysis has to date been performed in 10 cases (mean age: 59.9 years, 4 females). Six of these had proven infection while in 4 infection was excluded. Visual interpretation of 3-hr images alone classified all 10 cases correctly. Visual interpretation of white cell accumulation over 24-hr classified 9 cases correctly and resulted in 1 false negative. Finally, interpretation based on an accumulation index alone correctly classified 5 cases but resulted in 3 false negatives and 2 false positives. **Conclusion:** Based on preliminary data, there is no evidence to suggest that assessment of progressive white cell accumulation improves diagnostic accuracy of WCS for SVGI.

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Is Technetium 99 Metastable Nanocolloid a Good Substitute for Performing Milk Scans?

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Background: The milk scan is a nuclear medicine study that has been performed for more than over 30 years ago for the detection and quantification of gastroesophageal reflux (GER) in infants and children. The ideal radiotracer for this study should mix evenly with ingested food (milk), be non-absorbable from the gastrointestinal tract or respiratory mucosa, have no effect on GE and should not bind to gastrointestinal mucosa. These qualities have made 99mTc sulfur colloid the recommended radiotracer for performing milk scans, however due to its unavailability in South Arica (SA), tin colloid is used. Production and quality control challenges resulted in a period of sporadic availability of 99mTc 99m tin colloid in SA. Consequently, our facility used 99mTc nanocolloid as an alternative for milk scans. The effectiveness of this alternative for performing milk scans is not well known, even though an invitro study evaluating radiopharmaceuticals for GE studies showed that it might be an effective alternative. **Aim:** The aim of the study was to determine whether 99mTc nanocolloid was a suitable substitute tracer in performing milk scan studies in pediatric patients, and to compare its gastric emptying rate with that of 99mTc tin colloid. **Methods:** Twenty-seven milk scans performed with 99mTc were retrospectively assessed for identification of significant esophageal hold up, gastroesophageal reflux, pulmonary aspiration and gastric emptying. Scans were also assessed for liver, spleen and bone marrow uptake. Gastric emptying results were compared with those of 27 randomly selected normal gastric emptying studies performed using 99mTc tin colloid. **Results:** None of the studies had liver, spleen or bone marrow uptake, with all being interpretable. Significant esophageal hold up and gastroesophageal reflux was noticed in 30% and 48% of subjects respectively. Only 1 subject had evidence of pulmonary aspiration. All subjects had normal gastric emptying at 2 hours post radiolabeled milk ingestion. The average rate of gastric emptying at 2 hours was faster in the nanocolloid group as compared to the tin colloid group (8.85% retained ± 8.96% vs. 15.48% retained ± 10.52%, p= 0.016). **Conclusion:** Our findings show that 99mTc nanocolloid is a suitable substitute tracer for

performing milk scans, however we cannot ascertain if the smaller particle size of the nanocolloid compared to tin colloid affects gastric emptying rates. Therefore, different cut off values for normal gastric emptying might have to be used.

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Diagnostic Performance of ^{68}Ga-PSMA PET/CT in Patients with Biochemical Recurrence and a PSA Value of ≤2 ng/ml

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Background: Whilst the curative treatment of organ confined prostate cancer can yield excellent 5 year expected survival rates up to one third of these patients will re-present with suspected recurrence in the form of a detectable rising serum Prostate Specific Antigen (PSA) level (biochemical failure). Imaging in biochemical failure plays a very crucial role as patients may benefit from salvage radiotherapy if the site of prostate cancer recurrence is identified. ^{68}Ga-Prostate-specific membrane antigen (PSMA) is rapidly emerging as a significant step forward in the management of prostate cancer, based on the fact that Prostate-specific membrane antigen (PSMA) is a type II transmembrane protein with high expression in prostate carcinoma cells. **Aim:** The aim of this study was to determine the diagnostic performance of ^{68}Ga-PSMA PET/CT in patients with biochemical recurrence with a PSA of ≤ 2ng/ml. **Methods:** 45 Prostate cancer patients prostate (mean age 63.6±8, range 47-87 years) presenting with abnormal PSA (mean PSA 0.82±0.57 ng/ml, range 0.07-2) underwent contrast-enhanced ^{68}Ga-PSMA PET/CT. PET/CT findings were evaluated qualitatively and semiquantitatively (SUVmax) and compared to the results of histology, Gleason score, CT scan and bone scintigraphy. **Results:** ^{68}Ga-PSMA PET/CT was positive in 20 of 45 patients (44, 4%). The detection rates for PSA levels 0-<0.5, 0.5-<1, 1-2 were 25%, 50%, and 58.8% respectively. Solitary sites of recurrence were identified in 13 (65%) patients of which 11 (24.4%) were prostate confined. 7 (100%) of the patients who had radiotherapy only (brachytherapy or EBRT or both) demonstrated local recurrence on ^{68}Ga-PSMA PET/CT whilst 7 (25%) of the patients who had undergone prostatectomy demonstrated local recurrence. Lowest detected PSA value was at 0.15ng/ml **Conclusion:** ^{68}Ga-PSMA PET/CT demonstrated excellent diagnostic performance with the detection of recurrent prostate cancer in patients with PSA values as low as 0.15ng/ml and will significantly impact the way these patients could be managed.

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Correlation of 3D SPECT/CT based tumour absorbed doses and changes in Ga-68 DOTANOC metabolic parameters for patients with well differentiated metastatic neuroendocrine tumors receiving Lu-177 DOTATATE therapy

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Background: Treating patients with metastatic well differentiated neuroendocrine tumours (NET) with Lu-177 DOTATATE (Lu-DOTA) has shown promising results. 3D based dosimetry to assess absorbed doses to tumour lesions has recently been introduced. It is known that baseline Ga-68 DOTANOC (Ga-DOTA) PET/CT uptake (SUV) may predict clinical response after therapy. Only a few research studies have been done to assess relationship between Ga-DOTA SUV, tumour absorbed dose (TAD), and tumour response.
Aim: To estimate tumour lesion absorbed doses and correlate with changes in Ga-DOTA SUV parameters between baseline and post treatment PET scans. **Method:** Twenty one (21) lesions from four patients with metastatic NET who received four cycles of Lu-DOTA were selected. Complete 3D dosimetry was performed for each lesion using images acquired at different time points after Lu-DOTA infusion. The OLINDA® unit sphere model was used for TAD calculations. All patients underwent baseline Ga-DOTA scans and post treatment scans 3 months after 4th cycle. Standardized uptake values (SUV) were calculated for each lesion. Changes of these parameters between baseline and after treatment scans were calculated. **Results:** Mean TAD was 85 Gy (min: 32 Gy, max: 318 Gy). Significant correlation (Pearson r_p, $p<0.01$) between baseline Ga-DOTA SUV_{peak} and TAD was found ($r_p=0.67$). Baseline SUV_{mean} had highest correlation to corresponding percentage SUV change after therapy ($r_p=0.81$). **Conclusions:** 3D SPECT/CT TAD calculations are feasible. Pre-treatment Ga-DOTA SUV_{peak} correlate better with TAD while SUV_{mean} has superior correlation to corresponding post treatment percentage SUV change. A larger study is required to confirm these findings.

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Combined Versus Subtraction – Only Technique in Parathyroid Scintigraphy

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Background: Parathyroidectomy is the main form of treatment for patients with primary and tertiary hyperparathyroidism. Pre-operative localization of hyper-functioning parathyroid tissue depends on either a delayed washout technique, a subtraction technique, or as is the case in our institution, a combination of the two. While there is evidence that the subtraction technique is more sensitive, it is uncertain whether the addition of a delayed imaging phase, to assess for differential washout, confers any benefit in terms of the number of lesions detected. **Aim:** To determine whether a combined technique detects any additional hyper-functioning parathyroid tissue compared to using the subtraction technique alone in patients with hyperparathyroidism being considered for surgery. **Methods:** A retrospective analysis of parathyroid scans performed at Tygerberg hospital between January 2012 and October 2017 was performed. Scans were interpreted by consensus by three readers. The number of parathyroid lesions identified on review of the subtraction images (pertechnetate, sestamibi, and digital subtraction statics) was recorded. Immediately thereafter, the delayed sestamibi washout images were reviewed. Interpreters reported on whether the delayed washout images were concordant or discordant with the subtraction images and, whether discordant lesions were positive or negative. A McNemar's discordant pair's analysis was performed to detect a significant difference in the combined and subtraction-only approaches. A statistical threshold of $p < 0.05$ was considered significant. **Results:** To date, 48 cases have been reviewed (mean age 52.4 years, female: 37). Median parathyroid hormone level was 27.1 pmol/L (range: 7.9 – 504.9).The number of patients with primary, secondary, and tertiary hyperparathyroidism was 32, 10, and 6 respectively. A total of 98 parathyroid lesions were detected, 96 of which were identified on subtraction imaging alone, and 2 of which were only identified after viewing the delayed sestamibi image. In no case did the delayed sestamibi image change the final interpretation of a lesion from positive to negative. The difference between a subtraction-only technique and a combined (subtraction plus delayed) was not statistically significant ($p=0.25$). **Conclusion:** No benefit to a combined imaging technique (subtraction plus delayed phase) was demonstrated over a subtraction-only technique. Early results suggest that the delayed phase may be reasonably omitted when performing subtraction parathyroid scintigraphy. The results of a repeat analysis, including a larger sample, will be presented.

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Are All that Glitters Contamination?

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Background: Bone scintigraphy is a common imaging modality for various benign and malignant bone disorders. Due to its high affinity for calcium, a technetium 99m phosphonate compound like methyl diphosphonate (TC99m MDP) is used for imaging. Usually by 3-5 hours post tracer injection there is a good contrast between soft tissue and bone uptake. However, there are instances where soft tissue uptake is seen and this may be attributed to, among other things, soft tissue calcification or infarction and more commonly contamination. **Aim:** The aim is to bring awareness for the need for further imaging by technologists in order to identify whether soft tissue uptake may be mimicked by or attributed to contamination. **Method:** We illustrate two case studies with regard to the above mentioned aim. Case 1-A 69 year old female patient with right breast cancer and was referred for a bone scan as part of her staging workup. The patient was injected with 25mCi Tc99m MDP and whole body and static images were acquired 3hrs following radionuclide administration. Case 2-A 67year old female patient with adenoid cystic parotid cancer and also had a history of trauma to the right thigh approximately 16 years ago. A bone scan was requested and a dose of with 25mCi Tc99m MDP was given. Whole body static and SPECT/CT images were acquired 3hrs post injection. **Results:** Case 1: Symmetrical soft tissue uptake was noted in the groin region as well as on the right acetabulum. The patient was not decontaminated and no technical measure was used to discriminate between contamination and soft tissue uptake. It was rather left for the physicians to decide on how to interpret the visualised uptake. Case 2: Soft tissue uptake was noted lateral to the right greater trochanter. The patient was decontaminated and SPECT/CT was performed, which confirmed the presence of heterotopic ossification in that region. **Conclusion:** Although time consuming it is imperative that technologists pay attention to details and clean areas of suspected contamination in order to prevent misdiagnosis of soft tissue lesions as presumed to be due to contamination and vice versa. The case 2 as described in this abstract clearly illustrates the need for further imaging to reach that purpose.

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Strategies to Facilitate Nuclear Medicine Radiographers' Practices in the Processing and Assessment of Myocardial Perfusion Image Quality

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Background: Nuclear Medicine Radiographers (NMRs) play significant roles in the production of myocardial perfusion images and other nuclear medicine imaging procedures. Their roles extend from the time patients are booked for imaging procedures to the release of the patients from the department. Some of the roles are performed by NMRs such as imaging, while others are shared with other health professionals, such as the management of image quality. In South Africa, especially in the province in which this study was undertaken, NMRs' practices in the processing and assessment of myocardial perfusion image quality are inconsistent between Nuclear Medicine Departments. The inconsistencies manifest themselves from the time image acquisitions are completed to the time the NMRs transfer the images to the Nuclear Medicine Physicians (NMPs) for interpretation. **Aim and Methodology:** The aim of this qualitative research study was to explore and describe why these inconsistencies existed in order to develop strategies to facilitate the NMRs' practices in the processing and assessment of MP image quality. Focus groups and interviews were conducted with NMRs and NMPs respectively. Both the focus groups and interviews were audio-recorded and transcribed. Using thematic analysis, each useful and meaningful statement was assigned a code that captured its meaning and was relevant to the research questions. The codes were assigned using Atlas. ti 7 a software package for qualitative analysis. The codes were then grouped into families/categories that were allocated under themes. **Results:** Five themes emerged which included, the management of myocardial perfusion image data, resources to support NMRs in myocardial perfusion processing and assessment of image quality, challenges in processing and assessment of myocardial perfusion image quality, reasons why NMPs processed and assessed myocardial perfusion image quality and inter-professional relationships between NMRs and NMPs. Based on these findings, strategies to facilitate the NMRs' practices in the processing and assessment of MP image quality were developed. **Conclusion:** Since this research study was contextual in nature, the strategies developed should be applicable in similar contexts. Further, these strategies can be applied in full or in part depending on the need and will benefit the NMRs' practices in the processing and assessment of myocardial perfusion image quality.

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Validation of a Gamma Camera Modelled with SIMIND Monte Carlo Code

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Introduction: Dosimetry for targeted radiotherapy requires the accurate quantification of activity from gamma camera studies. Accurate activity quantification is difficult to achieve because of several effects that can lead to errors in activity estimates. These effects can be studied by using Monte Carlo simulations. The aim of this study was to validate gamma camera modelled by the SIMIND Monte Carlo program. **Materials and Methods:** The modelling and validation of a Siemens Symbia T SPECT/CT dual head gamma camera (Symbia T, Siemens Medical Solutions, Inc. Hoffman Estates, IL., USA) fitted with low-energy, high-resolution (LEHR) collimators was done by acquiring and simulating certain NEMA stipulated performance measurements. These performance measurements of the gamma camera without (intrinsic) and with (extrinsic) LEHR collimators were done for Tc-99m using a 15% energy window.(i) Measured and simulated energy spectra from point sources in air were compared with and without collimators.(ii) Extrinsic spatial resolution was obtained from two line sources at 10 cm distance from the detector head.(iii) The sensitivity and septal penetration of the gamma camera was obtained from a flat circular source simulated and measured at various distances from the detector head. These simulated and measured performance data were processed and the results compared. **Results:** The accuracy of the MC model was proved by the good agreement between measured and simulated intrinsic and extrinsic energy spectra. The intrinsic energy resolutions for the measured and simulated energy spectra were calculated to be 9.3 % and 10.0 % respectively. The corresponding values for the extrinsic energy resolutions were 9.6 % and 10.0 %. The Full Width at Half Maximum and Full Width at Tenth Maximum for the gamma camera for measured and simulated system spatial resolution were 7.3 ± 0.04 mm, 13.3 ± 0.04 mm versus 6.3 ± 0.06 mm, 11.5 ± 0.06 mm. The simulated sensitivity value (86.7 cps/MBq) was within 3.7% of the experimental values (90.0 ± 3 cps/MBq) for the circular sources at 10 cm from the collimator. The corresponding measured and simulated values for the septal penetration were 1.0 ± 0.4% and 0.6 %. **Conclusions:** Results obtained with the SIMIND MC code agree well with experimental results measured with Tc-99m with the Siemens Symbia T SPECT/CT gamma camera fitted with LEHR collimators. It is thus evident from this study that the SIMIND MC code can be used with confidence to mimic planar and SPECT studies.

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Assessing the Diagnostic Value of 90° Dynamic Imaging for Improved Visualization of Sentinel Lymph Nodes in Breast Cancer Patients at Inkosi Albert Luthuli Central Hospital, 2017

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Background: An important factor predicting long term survival in breast cancer is the assessment of axillary lymph node involvement, most accurately determined by a Sentinel Lymph Node (SLN) Biopsy and pre-operative nuclear medicine imaging, to identify and localize the SLN thus enabling accurate staging, prognostication and treatment planning with minimal morbidity for the patient. Optimizing the imaging technique to clearly identify the sentinel lymph node and lymphatic channels will provide surgeons with a clearer lymphatic map and successful localization and resection of the sentinel node/s. **Aim:** This study aims to assess the value of using a 90° camera orientation during dynamic imaging to localize breast cancer SLN. **Method:** An observational, descriptive, cross-sectional study was conducted prospectively on sentinel lymph node patients with early stage breast cancer referred to the Nuclear Medicine department at Inkosi Albert Luthuli Central Hospital (IALCH) between February 2016 and 2017. Sociodemographic and clinical data were obtained from the Hospital Information System (HIS) and Radiological Information System (RIS). Three Nuclear Medicine physicians evaluated the images blinded to all related patient data. Dynamic images acquired with the two orientations, namely anterior-lateral 90° (AL-90) orientation and anterior-posterior 180° (AP-180) orientation. We evaluated the imaging orientation that is superior in visualizing the lymphatic tract, sentinel lymph node and second tier nodes. **Results:** We reviewed 83 patients (82 females and 1 male) aged between 40 and 79 years (mean 59.5±12.37) who underwent sentinel lymph node imaging. In the AP-180 orientation, the lymphatic tract, sentinel node and second tier node were seen on the anterior images in 60%, 84% and 33% of patients respectively vs. 33%, 80% and 13% on the posterior images. In the AL-90 orientation, the lymphatic tract, sentinel node and second tier node were seen on the anterior images in 63%, 86, 84% and 42% of patients respectively vs. 86%, 89, 47% and 39% on the lateral images. **Conclusion:** This study has demonstrated the significant improvement in visualization of the lymphatic tract, sentinel node and second tier nodes when imaging patients in an anterior-lateral position with overall superiority seen on the lateral images. In conclusion, dynamic imaging in the 90° orientation is superior to 180° anterior-posterior imaging when visualizing the lymphatic tract, second tier nodes and sentinel lymph node. This orientation is recommended to improve accuracy and localization of sentinel lymph node mapping.

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The Incremental Value of SPECT in the Evaluation of Patients with a History of Lower Back Pain

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Background: Bone scintigraphy can be seen as one of the most significant diagnostic tool in the evaluation of bone abnormalities. Lower back pain is a common indication and imaging around the vertebrae region has posed some difficulties due to its multifaceted structure making it problematic for planar imaging to detect abnormalities in this region. SPECT is mostly used in conjunction with planar imaging to allow more accurate diagnosis and anatomic localization of osteoblastic and osteolytic lesions in 3D mode. **Aim:** The purpose of this study is to assess the necessity of SPECT in patients with known history of lower back pain, whose technetium-99m methylene diphosphonate (MDP) bone scans planar images showed no focal spine uptake. **Method:** We retrospectively reviewed bone scan reports of 22 patients, both males and females. All patients had a history of lower back pain but no history of surgery or trauma to the spine. Both planar and SPECT imaging was performed on all patients. The randomly selected group of patient's planar imaging was reported as normal or diffuse uptake of the lumbar spine and no focal uptake. **Results:** SPECT imaging was able to visualize abnormal spine variants in 59% (13/22) of the patients whereas planar images appeared normal. 41% (9/22) of the patients planar and SPECT images were congruent. 61% (8/13) of abnormalities on SPECT were likely to be of an inflammatory/degenerative nature. 23% (3/13) likely to be of an osteoblastic metastatic nature while 15% (2/13) likely to represent an osteophyte nature. **Conclusion:** SPECT imaging should be used in conjunction with planar imaging in the evaluation of patients with a history of lower back pain. Its incorporation in bone scan procedures is crucial for accurate diagnosis, eradication of false-negatives and improved patient management.

Radiopharmacy

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Production and Evaluation of a TiO_2 based $^{68}Ge/^{68}Ga$ Generator

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^{68}Ge/^{68}Ga generators rely on metal oxide, inorganic and organic sorbents in order to prepare radionuclides useful for clinical applications. The requirements for ^{68}Ge/^{68}Ga generators are that the ^{68}Ga obtained from the ^{68}Ge loaded column should be optimally suited for the routine synthesis of ^{68}Ga-labelled radiopharmaceuticals, that the separation of the ^{68}Ga daughter from the ^{68}Ge parent should happen easily, with a high yield of separation, a low specific volume of ^{68}Ga and should not contain trace elements owing to the solubility of the metal oxide sorbent. Beginning with a metal oxide preparation and continuing through recent developments, several approaches for processing generator derived ^{68}Ga have altered the production of ^{68}Ge/^{68}Ga generators. Still, the effects of sorbent modification on the properties of ^{68}Ge/^{68}Ga radionuclide generator systems are not necessarily optimally designed for direct application in a medical context. The objective of this research was to analyze and document characteristics of Titanium Oxide (TiO_2) sorbents relevant to processing of a ^{68}Ge/^{68}Ga generator that is able to produce ^{68}Ga eluates that are adequate for clinical requirements.

Interest was shown in TiO_2 based ^{68}Ge/^{68}Ga generators by a number of overseas companies for tumour imaging using ^{68}Ga-labelled 1,4,7,10-tetraazacyclododecane-1,4,7,10-tetraacetic acid (DOTA)-conjugated peptides. While a method involving production of the ^{68}Ga radionuclide using TiO_2 metal oxide had been published, problems with the production persisted. A method, using TiO_2 metal oxide for ion exchange chromatography, was devised in this study to produce the ^{68}Ga radionuclide, with the aim of being adopted for production purposes. The study focuses on the development of a dedicated procedure for the achievement of sufficient ^{68}Ga yield along with low ^{68}Ge breakthrough and low metallic impurities.

By means of the characterization techniques used, particle size, mineralogical phase and amorphous nature seemed to be influenced by the pre-treatment temperature applied to the commercial TiO_2 powders. Increased surface area and anatase nature of the TiO_2 powders (Sigma-Aldrich) suggested that the particle size of this source of TiO_2 was smaller and that no heat was necessary for the ^{68}Ge loading. The behaviour of the generators corresponded well to the technical characteristics required by the regulators in the market of the ^{68}Ge/^{68}Ga generators. Recent developments in ^{68}Ga regeneration have heightened the need for maximization of the yield of the desired radionuclide and minimization of the yield of the radioactive contaminants. In the past, far too little attention has been paid to the strict regulatory and quality requirements. This study has been able to show the separation technique, generator system design and provided ^{68}Ga elution yield and radiochemical purity (i. e. low breakthrough of the long-lived parent radionuclide).

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Comparative Evaluation of Acetamidobenzoxazolone Based PET/SPECT Biomarkers for TSPO Mapping During Neuroinflammation

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Background: Development of radio-ligand for Translocator Protein [18 kDa, TSPO] to study its role in activation of glial cells in the injured brain as well as in inflammatory condition, is one of the most critical issues of biomedical imaging. It has found that TSPO expression is markedly upregulated in such inflammation conditions and easily correlated to the extent of microglial activation, making the quantification of TSPO density a standard indicator for brain diseases. **Aim:** Herein, we are showing the synthesis, characterization, and the in vitro evaluation of a new TSPO selective SPECT ligand, 2-(5-(2-(bis(pyridin-2-ylmethyl)amino) acetamido)-2-oxobenzo[d]oxazol-3(2H)-yl)-N-methyl-N-phenylacetamide (PBPA) and carbon-11 labelled *N*-methyl-2-(5-((naphthalen-2-ylmethyl)amino)-2-oxobenzo[d]oxazol-3(2*H*)-yl)-*N*-phenylacetamide, which fulfils the requirements for a bifunctional chelate approach. **Methods:** Herein we are describing the synthesis, in silico and in vitro analysis of novel benzoxazolone based designed ligands. Both the target molecules were synthesized in good yield by following the convergent methodology approach. Docking analysis of synthesized ligands and co-crystallized ligand was performed on 2MGY. To determine specific binding with TSPO on neuroinflammation of the brain, *in vitro* autoradiography (ARG) and PET studies were performed in ischemia rat model. **Results:** Characterization and validation of all synthesized compounds was done with different spectroscopic techniques (NMR, FTIR and HRMS). The obtained G Score from CADD studies signifies the efficient binding potential which was confirmed by in vitro Ki in nanomolar range. SPECT Biodistribution studies in mice revealed the maximum brain uptake (2.51 ID g^{-1}) at 10 min past administration. The order of maximum localisation of radiolabeled drug in different organs is lungs, liver, spleen followed by kidney. The dynamic scintigraphic scan carried out in rat correlated with findings of organ distribution study.

PET Biodistribution studies confirm high accumulation of radioactivity in the TSPO-rich organs like lungs, heart, kidney and adrenal glands. In vitro autoradiography stated significantly increased binding on the ipsilateral side rather than contralateral side of rat brains. Blocking experiments with unlabelled TSPO specific ligands MPMB or (PK11195) minimised the difference in uptake between the two sides. **Conclusion:** In conclusion on the basis of animal biodistribution data, and PET/SPECT images these acetamidobenzoxazolone ligands have shown promising aspect to image TSPO. Further primate's study is required to evaluate the usefulness of this compound before clinical use.

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Implementation of Environmental Monitoring in a Low Income Radiopharmacy Unit

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Background/Aim: As part of quality assurance, environmental control is of utmost importance to protect radiopharmaceuticals against microbial contamination. The department of Nuclear Medicine at Yaoundé General Hospital in Cameroon has introduced a quality control program including media fill tests, sterility test of products and passive air sampling using settle plate exposure. This presentation evaluates the trends of air quality monitored by settle plate exposure over the year 2017. **Methods:** Passive air sampling was performed by positioning opened tryptic soy agar settle plates (TSA diameter 90 mm) for 2 to 4 hours at six predetermined locations where radiopharmaceuticals are prepared and dispensed. Samples were taken while radiopharmaceuticals were prepared ("during activity"), and while the facility was not used ("at rest"). After exposure the plates were incubated at 30 to 35 °C for 72 hours and the number of colony forming units (CFU) per hour was determined. Where possible, plates were sent to the microbiological unit for identification of microorganisms. Based on the GMP grade of the sampling location and the corresponding action limits, the percentage of settle plate results exceeding the action limit were recorded. Several interventions aimed at improving cleanliness of the Radiopharmacy environment were introduced after 6 months. Post intervention sampling was continued for 6 months to evaluate the effect of the interventions. Student's T test ($P<0.05$) was used to evaluate the results. **Results:** 77 samples at rest and 40 samples during activity were collected at each site before intervention, versus 76 samples at rest and 33 samples during activity after the intervention. The reduction in percentage of plates exceeding the action limit were as follows: In the closed cabinet at rest: 51% in site1 and 60% in site 2; during activity: 49% in site 1 and 36% in site 2. In the LAF at rest: 12% in site 1 and 16% in site 2; during activity: 11% in site1 and 12% in site 2. In the open bench area at rest 45% and during activity 45%. On the lab floor, the decrease was 6% at rest and 10% during the activity. The microorganisms identified were Staphylococcus epidermis, Bacillus Gram+ and Candida Sp. Significant improvements were found at all sample locations with all $p \leq 0.05$ ($P_{CC} = 0.008$, $P_{LAF} = 0.041$; $P_{OB} = 2E\text{-}6$; $P_F = 0.0001$). **Conclusion:** Passive air sampling was implemented and confirmed that interventions led to an improvement in the air quality in our Radiopharmacy.

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The NuMeRI Preclinical Imaging Facility – The Gateway to Bench-to-Bedside Translational Research

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Background/Aim: In 2016 the South African Nuclear Energy Corporation (Necsa), the Department of Science and Technology (DST)/Preclinical Drug Development Platform (PDDP) at North-West University (NWU) and the Department of Nuclear Medicine of Pretoria University pooled resources to become pioneers in introducing real-life *in vivo* molecular imaging of small animals to South Africa. This preclinical imaging facility (PCIF) demonstrates applied, translational research, brings bench-to-bedside innovations and is currently driving the development of an approved large-scale Nuclear Medicine Research Infrastructure (NuMeRI), unique to South Africa. **Technologies:** The PCIF competence team includes an integrated group of radiochemists, nuclear physicians, radiographers, microbiologists, biochemists, pharmacists, veterinarians and laboratory animal technicians. The PCIF technologies are housed *ad interim* at Necsa and comprises of a one-stop laboratory with state-of-the-art, high-resolution scanner using positron emission tomography/computed tomography

(μPET/CT) and single-photon emission computed tomography/computed tomography (μSPECT/CT) for small animal anatomical and molecular (bio-functional) imaging. The PCIF's latest addition, a bioluminescence imaging systems will be further complemented by an autoradiograph. The PCIF was also extended by a certified animal housing and handling area, areas for radioactivity handling and analysis and specialized information technology equipment. The animal models are established and provided by the Vivarium of the DST/NWU PCDDP which is accredited by the association for assessment and accreditation of laboratory care international (AALAC) and further certified by the South African national accreditation system (SANAS). Both the DST/NWU PCDDP and Necsa are compliant with good laboratory practise. **Capabilities:** The PCIF allows for projects including demonstration of pharmacokinetics and pharmacodynamics of prototype drugs or radiopharmaceuticals in real time using wild-type or diseased mouse, rat, guinea pig or small rabbit models. Other supporting capabilities of the PCIF are autoradiography, blood chemistry analysis, hematology, *in vivo* toxicity evaluation, animal model development, radiation dosimetry, bio-analytical services and the production of various nuclear isotopes (including the radiolabeling of compounds). The opportunity of sophisticated (longitudinal) study designs are aligned with state-of-the-art analytical software providing high-quality and maximized research output from every animal. **Conclusion:** The PCIF goals are in direct alignment with a National Development Plan (Vision 2030); it will built capacity, increase socio-economic stability and, most importantly, develop the capabilities of the South African health systems to diagnose and treat diseases earlier. This facility welcomes both the academia and the commercial sector to be a part of this exciting new development and ensure that promising drug candidates are further evaluated in the drug delivery pipeline.

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The Effect of Incubation Time and Operator on Red Blood Cell Labelling Efficiency in Breast Cancer Patients at Dr George Mukhari Academic Hospital

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Introduction: The study aimed to perform quality control (QC) for ^{99m}Tc-RBC labelling to determine the patient-related and process-related factors which may affect the labelling efficiency of ^{99m}Tc-RBCs from the *in vivo* method, in blood samples from breast cancer patients who underwent multi-gated acquisition (MUGA) scans at the Department of Nuclear Medicine. This presentation focusses on the effect of operator and radiolabeling incubation time on labelling efficiency. **Methods:** The ^{99m}Tc radio-labelling efficiency of red blood cells (RBCs) that had undergone *in vivo* radio-labelling method was measured in samples from 30 patients who underwent a MUGA scan. Stannous pyrophosphate (Sn-PYP) was injected intravenously at a target time of 20 minutes later ^{99m}Tc-pertechnetate was injected. The time between Sn-PYP injection and $Na^{99m}Tco_4$ injection was noted, as was the radiographer. After written informed consent had been obtained, three 3ml blood samples were collected from each patient, centrifuged at 2000rpm for 5 minutes at normal body temperature and washes with normal saline three times to carefully remove the free ^{99m}Tc from the samples. The activity of the samples was measured using both the dose calibrator. Labelling efficiency was calculated:
% RBC Labelling (LE) =
Results: Over the study period, four radiographers (operators) performed red blood cell labelling for the patients to undergo MUGA scans. Operator 3 had the highest average LE of 86% (+/-5.99); operator 2 had the lowest LE of 59% (+/-28.09). The LEs that were below the minimum acceptable value of 70% were mainly caused by the deviation of operators from the prescribed 20 minute waiting period between the injection of pyrophosphate and ^{99m}Tc-pertechnetate. This deviation negatively impacts the quality of MUGA images. The LEs for an incubation time of less than 20 minutes were 46%+/-31.57%, whereas incubation times of 20-30 minutes resulted in statistically significantly higher LEs of 80% +/-21.49 (p=0,02). **Conclusion:** The incubation time-lapse between the injection of Sn-PYP and ^{99m}Tc-pertechnetate plays a significant role in ensuring that there is enough time for the freely diffused stannous ions (Sn^{2+}) in the RBCs to reduce ^{99m}Tc-pertechnetate so it can remain trapped in the cell, thus yielding LEs above the suggested acceptable threshold of 70% for in vivo RBC radiolabeling. Therefore, operators should be made aware of the importance of adhering to an incubation time of at least 20 minutes.

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Cardiotoxic Effects of Chemotherapy Drugs used in Breast Cancer Patients at Dr George Mukhari Academic Hospital Using Multigated Acquisition Scans

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Introduction: The aim of this study was to assess cardiotoxicity in breast cancer patients at Dr George Mukhari Academic Hospital (DGMAH) by monitoring cardiac function before commencement of chemotherapy and during the course of treatment, by determining the change in Left Ventricular Ejection Fraction (LVEF) using Multi-gated Acquisition (MUGA) scans. **Objectives:** Obtain demographic, clinical and laboratory data, as well as details of current and previous therapy for patients due to receive chemotherapy at the Breast Oncology Clinic DGMAH. Measure LVEF (via MUGA scans) in breast cancer patients at DGMAH prior to commencement of chemotherapy treatment and at set points during the chemotherapy treatment cycle. Compare the change in LVEF levels between the time points and identify variables that may be associated with the change in LVEF (e. g. chemotherapy regimen, age, concomitant treatment and disease). **Methods:** A descriptive prospective and retrospective study was performed in 40 breast cancer patients at Dr George Mukhari Academic Hospital (DGMAH). After informed consent had been obtained, patient demographic and cardiovascular assessment data, laboratory and breast cancer data and MUGA scan data were collected. **Results:** The mean % LVEF for the first MUGA scan was 64, 2 ± 7, 7 and for the last MUGA scan was 60, 5 ± 8, 5. There was a drop in LVEF in 25 out of 40 (62.5%) of all patients. Fifteen out of 40 (37.5%) retrospective and prospective patients had a drop in LVEF of more than 10% from the first MUGA scan to the last MUGA scan. Six out of 40 (15%) of the patients met the criteria of chemotherapy-induced cardiotoxicity (10% drop in LVEF and a LVEF <55%).The proportion of cardiotoxicity cases was 1/6 and 5/6 for prospective and retrospective patients, retrospectively. The difference between the first MUGA scan and last MUGA scan was statistically significant ($p < 0,04$). **Conclusion:** A decline in LVEF during a 6-month period of chemotherapy is evident as seen from the study. This indicates that signs of cardiotoxicity manifest at an early stage during chemotherapy treatment with anthracyclines. **Recommendations:** Protocols to monitor LVEF at set point intervals should be written for breast cancer patients. All patients should undergo a baseline MUGA scan and at least two subsequent MUGA scans: in the middle of chemotherapy treatment and after chemotherapy treatment. Patient follow up should also be long term in order to identify late cardiotoxic effects that may develop.

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A Comparison of ITLC Stationary Phases for Routine Radiopharmacy Quality Control

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Introduction: The choice of stationary phases for radiopharmacy Quality control (QC) depends on factors such as cost, the development time, ease of handling and subsequent resolution. The study compared Agilent Instant Thin Layer Silica Gel glass microfiber paper (ITLC-SG paper) and Whatman 31E Thin Layer Chromatography plates (TLC plates) to establish which would be preferable for routine ITLC QC. **Objectives:** The objectives were to determine whether Agilent ITLC-SG glass microfiber paper gave comparable results to plastic TLC-SG plates and to determine the development time of both systems. **Methods:** ITLC-SG Paper and Plastic TLC-SG plates were compared for QC of ^{99m}Tc-pertechnetate and ^{99m}Tc-MDP. Methyl ethyl ketone was used as the mobile phase. Three strips of the stationary phases were used for each of the three samples of each radiopharmaceutical and analysed with a 'cut and count' method and by radiochromatograms (a total of 18 strips of each of the ITLC-SG paper and TLC-SG plates). The stationary phases were cut into the same sizes. An ionization chamber (Atomlab™ 500 for cut and count) and a chromatography scanner (Lablogic Radio-TLC Detector with Laura 4.2.450 software) were used to quantify the activities on the sample strips. A stop watch was used to measure the development times. **Results:** From the radiochromatographic scans, the analytical results, using three samples of ^{99m}Tc-Sodium Pertechnetate to check for hydrolysed reduced ^{99m}Tc (HR^{99m}Tc) were not significantly different for the two stationary phases (%RCP = 99.9 paper vs 100 plastic, p=0.35), but the development time was significantly different (ITLC-SG paper average 3.28 minutes vs 8.70 minutes for plastic TLC-SG plates, p=1.03E-06). A comparison of the stationary phases using three samples of reconstituted ^{99m}Tc-MDP produced ITLC-SG paper results that differed from the plastic TLC plates (%RCP = 84.3 paper vs 97 plastic) but not statistically significantly so (p= 0.09). The main difference was from the sample 2 which was of lower activity than samples 1 and 3. The development times were significantly different; ITLC-SG paper average 2.81 minutes vs 9.66 minutes for the Plastic ITLC-SG plates p= 5.96101E-09. **Conclusion:** ITLC-SG paper has proven to give analytical results similar to those of the TLC-SG Plates for HR^{99m}Tc and ^{99m}Tc-MDP. Both stationary phases need care when handling. Given the considerably lower cost of the paper and the faster development time, ITLC-SG paper is the stationery phase of choice. Also, because of radiation exposure and development of impurities with time, ITLC-SG paper would be better option for RCP testing in the above cases.

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Patient education and preparation for scintigraphy at a tertiary hospital Nuclear Medicine Department in South Africa

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Background and Objectives: Patient education is an important, but often neglected aspect of patient care. Patient education is especially important in Nuclear Medicine scintigraphy, which is a relatively new concept for patients in most developing countries. The mention of the word 'Nuclear' or 'Radiation' may create apprehension in patients, hence it is important to educate patients about the processes and benefits of Nuclear Medicine. Effective patient preparation plays an essential role in obtaining good quality scintigraphic images. The objectives of the study were to assess initial information given to patients, to assess patient compliance with the required preparation procedures, to identify additional information required by patients and based on the results to prepare a general Nuclear Medicine procedure information leaflet for patients undergoing scintigraphy at out tertiary academic hospital. **Method:** A descriptive, cross-sectional study was conducted amongst a sample size of forty eight adult patients, newly-referred to the Nuclear Medicine Department for thyroid (sample size 30 patients) and lung (sample size 18 patients) scans for the period February to July 2017. After informed consent had been obtained, face to face interviews were conducted before and after the diagnostic scans to obtain information about patient knowledge of the procedures that they were undergoing. During the procedures, information was obtained by observation. Data analysis was descriptive and results are presented in tables and graphs. **Results:** Despite the fact that scintigraphy scan information can be obtained from external sources other than from healthcare professionals, 90% of the patients had no prior knowledge about their tests. 30% of the thyroid patients and 22% of the lung patients were initially fearful of the scans. Patients were generally not give adequate information prior to imaging. In many cases information was only verbal. In preparation for the thyroid imaging, 50% of the patients were asked to stop taking iodine-containing foods. All patients who were taking anti – thyroid hormones were asked to discontinue the medication a week before imaging. **Conclusion:** The study revealed that there are gaps in patient education and preparation for Nuclear Medicine imaging scans in our hospital. The majority of patients were less anxious after the scans, though they were initially anxious and did not know what to expect. Hence the importance of patient education and preparation prior to procedures in order to reassure patients, obtain quality images and improve diagnosis. A colourful patient information leaflet was developed and will be introduced in the department.

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Manufacture of Rb Metal Targets for Production of Sr-82: Non-Destructive Evaluation

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Background: The first trip to producing API grade Sr-82 ($t_{1/2}$ = 25.34 days) is the selection and manufacture of a target for bombardment by high energy protons (66 MeV). In this case, stainless steel (316) target capsules were filled with molten Rb metal atmosphere in a glove box under an argon atmosphere. To guarantee that the target filling is consistent with no variations in thickness of physical geometric defects (inclusions, voids, cracks), non-destructive testing (NDT) visualisation was performed on the prepared targets. This information could then be used to construct a visualisation quality assurance of the targets. **Aim:** Non-destructive visualization of Rb metal targets to examine their internal structure consistency. **Methods:** Four targets (from 99.9% rubidium metal) were preparing in a glove box under an argon atmosphere. After allowing the targets to cool to ambient temperature, they were sealed, weighed, and the mass of rubidium in each target was correlated with the internal volume of the target container. Radiographic and ultrasonic images of the whole targets are obtained using: (i) industrial x-ray radiography; (ii) ultrasonic testing; and (iii) neutron radiography. **Results:** Carefully study of the images created by the selected methods allowed us to accurately ascertain the distribution of rubidium in the target as well as the presence of voids. The ultrasonic images were very useful in showing metal uniformity and distribution, while the x-ray images displayed void defects consistently. Neutron radiography images are complimentary to x-rays but we seem to exhibit density variations of the solidified metal better than the x-rays. **Conclusion:** The methods used to evaluate the prepared rubidium metal targets were found to be appropriate to visualize the internal consistency of the solidified metal.

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Ga-68 yield and Ge-68 breakthrough of SnO2 based Gallium-68 generators

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Background: The yield of Ga-68 and breakthrough of Ge-68 iPod are important aspects of Ge-68/Ga-68 germanium generator function. Our centre uses SnO2 based Ga-68 generators produced by iThemba Labs. Ga-68 yield appeared variable, and Ge-68 breakthrough was observed, but seem to differ between generators. **Aim:** The study aimed to evaluate the influence of the age of the generator, the number of elutions performed, and the interval between elutions on Ga-68 yield and Ge-68 breakthrough, in order to optimize the use of Ga-68. **Methods:** Elution records of 8 generators, used between January 2013 and March 2018, were reviewed. The first five generators were eluted with 1 M HCl, and the last three generators was with 0.6 M HCL. Ge-68 breakthrough was measured after decay of eluted Ga-68. The age of the generator and the time interval between elutions were calculated and plotted against breakthrough and yield. **Results:** The generators were used for periods ranging from 128 to 372 days and the number of elutions per generator ranged between 28 and 151. Yields within the first month were between 119 % and 133 % of the nominal Ge-68 activity on the column for generators eluted with 1 M HCl, and 101 to 110 % for those eluted with 0.6 M HCl. By 160 days the yields had decreased to 106 % to 110 % with 1 M HCl elutions and 80 % to 99 % with 0.6 M HCl eluant. Three generators, including those eluted with 0.6 M, showed Ge-68 breakthrough within the first 10 days of use. By 160 days age, the Ge-68 breakthrough varied between 0.02 % and 1.0 %, with the lower acidity eluant giving the second highest value. There was no clear correlation between interval between elutions and Ge-68 breakthrough and Ga-68 yield. **Conclusion:** Due to irregular intervals between elutions, it is difficult to compare elution yield at various ages of generators. Behaviour of generators is difficult to predict, but all generators clearly functioned poorer with increased use. The increasing Ge-68 breakthrough, and especially breakthrough early in the lifespan of three generators, is of concern, as it creates long-living radioactive waste. Elution with a less acidic eluant provides a lower yield but also lower Ge-68 breakthrough.

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An automated synthesis method for them labelling of Ga-68 ubiquicidine

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Background: Ubiquicidine (UBI) 29–41 is currently being investigated as a potential infection imaging agent. All published methods for radiolabelling of this trace to date describe manual processes. The current manual method for labelling you UBI 29–41 with Ga-68 has several disadvantages, including unnecessary radiation exposure to operators, and difficulty to meet GMP requirements. **Aim:** The aim of the study was to develop an automated synthesis method for the labelling of Ga-68 UBI. **Methods:** Ga-68 for radiolabelling was obtained from an iThemba Ga-68/Ge68 generator, using fractional elution with 0.6 M HCl. NOTA-UBI was procured from BL Biochem (Shanghai, China). The approach to developing an automated method was to first duplicate the manual method developed by Ebenham *et al** using the generator, eluant and consumables available at our PET centre. Next, the manual method was adapted to suit a Scintomics protocol, e.g. adapting volumes for the synthesis unit. The radiolabelling yield and radiochemical purity were determined after each labelling experiment. **Results:** The volume (± 0.55 ml) of sodium acetate used in manual labelling to adjust the pH of the labelling mixture was too small for use in an automated synthesis process. It was decided to use a 1.5 M HEPES buffet to adjust the eluate to an acceptable pH. Elaute volumes ranging from 1.0 to 2.0 ml were used to which 1.2 to 1.6 ml of HEPES buffer was added and the pH measured in order to find the most suitable combination of eleuate volume and buffer volume to render a mixture with a pH between 3.5 and 4.0. Results indicated that 1.4 ml to 2.0 ml eluate and 1.2 ml HEPES buffer was suitable for use in the development of an automated synthesis method. Four successful automated labellings were performed using the HEPES buffer with an average decay-corrected radio – yield of 88.97% and a radiochemical purity of 99.49%. **Conclusion:** An automated synthesis protocol using a Scintomic GRP module has been successfully developed and tested. This protocol can be utilised for the routine the synthesis of Ga-68 UBI under GMP conditions.