REFERRAL INFORMATION FOR DIAGNOSTIC NUCLEAR MEDICINE PROCEDURES

The Ionising Radiation (Medical Exposure) Regulations 2017 (IRMER) Regulations

This document contains referral information about all common procedures that are carried out by the University Hospitals of Derby and Burton (UHDB) Nuclear Medicine Service.

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INTRODUCTION

IRMER	Any individual that requests a procedure to be carried out by the Nuclear Medicine Service is classified under **The Ionising Radiation (Medical Exposure) Regulations 2017 (IRMER) Regulations** as a **"referrer"**. Referrer's responsibilities are outlined in the Clinical Guideline for Radiological Imaging (IRMER) - Requesting Reference No. CG-RAD/2019/003 Referrers are legally responsible for all information they provide when requesting a nuclear medicine procedure to be carried out. Referrers are encouraged to use the information within this document. This will assist the process of justification and authorisation that must be performed for all Nuclear Medicine procedures. ***Failure by a referrer to provide the correct information for a requested procedure will result in the request being returned to the referrer.*** ***In some cases the request will be passed to an ARSAC licence holder for justification.***
Contact Details:	If you require any additional information about nuclear medicine procedures: **RDH Nuclear Medicine Department (88196/88197)** If you require medical advice with regard to a particular request for a nuclear medicine procedure to be undertaken, contact the Lead Nuclear Medicine Radiologist or one of the ARSAC licence holders below: • Dr Jim Birchall - Lead Nuclear Medicine Radiologist • General Diagnostic Procedures (Dr N Cozens) • Cardiac Diagnostic Procedures (Dr J Birchall) • Thyroid Cancer Therapy (Dr R Vijayan) • Prostate Cancer Therapy (Dr P Das) • Thyrotoxicosis Therapy Procedures (Dr E Ali, Dr S Sugunendran,)

General Information

- Patients are often required to lie still for 20 minutes or more.
- For optimum image quality, the camera heads are usually required to move very close to the patient.
- The weight limit for the camera couches is 200- 220kg, but scanning without the couch is sometimes possible.
- Pregnancy and breast feeding are often relative not absolute contraindications for many nuclear medicine studies. It is always advisable to contact the nuclear medicine department for more advice.
- For many studies, rather than two planar images, the camera is rotated around the patient giving a 3D volume which can be reconstructed in all three planes – this is called “Single Photon Emission Computerised Tomography” (SPECT).
- For a number of studies, including tumour specific imaging and myocardial and cerebral perfusion imaging, a low dose CT is performed on the same camera for the purpose of localization/attenuation correction.

If you anticipate difficulty with any of the above, please contact the Nuclear Medicine service for assistance.

CARDIOVASCULAR SYSTEM

Myocardial Perfusion Scintigraphy – Sestamibi/Tetrofosmin

Title of Investigation	Radionuclide Cardiac Perfusion Scan
Background	Radionuclide myocardial perfusion imaging is a procedure that utilises intravenously administered radiopharmaceuticals for the estimation, detection and evaluation of ischaemic heart disease (IHD). The distribution of myocardial perfusion is assessed after stress (either pharmacological stress or exercise), and usually compared to the distribution in the resting state.
Clinical Indications	Assessment for myocardial ischaemia/infarction, and if present, site, severity and extent To assess ischemia or myocardial viability in patients with known IHD being considered for CABG or PCI Stable angina but uninterruptible ECG (eg LBBB)
Contra Indications **Contraindications for stress**	Pregnancy and Breast feeding. Unstable angina (a study while in pain will give the same information as stress) Patient who is not comfortably weaned from nitro-glycerine infusion or is medically unstable. Tight aortic stenosis Significant dysrhythmia Patient with extremely high blood pressure. Recent infarct (Relative contraindication – rest study would give site and extent of infarction. If stress is required, must be discussed with cardiologist and performed under **medical supervision**)
Method and Characteristics	Stress images are usually compared with the rest images (for some patients no rest test is necessary if the stress test is normal). An important attribute of the test relates to its good "negative predictability" for imminent cardiac events. The technique has a place in the direction of any, or further, intervention(s), the follow-up of earlier events and in risk assessment.
The Patient	The patient may need to attend on 2 separate occasions, once for the stress test and once for the rest test. The stress test takes about 2 to 3 hours and requires strict preparation, including withdrawal from certain medication and caffeine.
Radiation Dose to Patient	4 mSv from each administered dose of 400 MBq. (Tc99m Sestamibi – 2 day protocol)

Comments	Patients in LBBB should be chemically stressed For the assessment of viability with these agents nitrate enhanced rest is used.
References	NICE guidelines: CG 95 (2010) Chest Pain of recent onset CG94 (2010) Unstable Angina and NSTEMI TA73 (2003) Angina and Myocardial Infarction – Myocardial Perfusion Scintigraphy SNM Procedure Guidelines for Myocardial Perfusion Imaging 3.3 (2008) EANM/ESC Procedural Guidelines for Myocardial Perfusion Imaging in Nuclear Cardiology. Eur. J. NMMI. Vol.32, No. 7, (2005) BNMS Procedure Guidelines for Radionuclide Myocardial Perfusion Imaging (2003) Lavalaye JM, Schroider-tanka JM et al. (1997) implementation of technetium-99m MIBI SPECT imaging guidelines: optimising the two-day stress protocol. International Journal of Cardiac Imaging (13(4): 331-51 Aug Pete Shackett (1999) Nuclear Medicine Technology - Procedures and Quick Reference. Lippincott Williams and Wilkins

Myocardial Perfusion Scintigraphy – Thallium

Title of Investigation	Radionuclide Cardiac Perfusion Scan
Background	Radionuclide myocardial perfusion imaging is a procedure that utilises intravenously administered radiopharmaceuticals for the estimation, detection and evaluation of ischaemic heart disease (IHD). The distribution of myocardial perfusion is assessed after stress (either pharmacological stress or exercise), and usually compared to the distribution in the resting state.
Clinical Indications	This is our preferred approach for assessing for viability. Assessment for myocardial ischaemia/infarction, and if present; site, severity and extent. To assess ischaemia or myocardial viability in patients with known IHD being considered for CABG or PCI. Stable angina but uninterruptible ECG (eg LBBB).
Contra Indications **Contraindications for stress:**	Pregnancy and Breast feeding. Unstable angina (a study while in pain will give the same information as stress) Patient who is not comfortably weaned from nitro-glycerine infusion or is medically unstable. Tight aortic stenosis Significant dysrhythmia Patient with extremely high blood pressure. Recent infarct (Relative contraindication – rest study would give site and extent of infarction. If stress is required, must be discussed with cardiologist and performed under **medical supervision**)
Method and Characteristics	Stress images are usually compared with the rest images (though for some patients no rest test is necessary if stress test is normal). An important attribute of the test relates to its good "negative predictability" for imminent cardiac events. The technique has a place in the direction of any, or further, intervention(s), the follow-up of earlier events and in "risk assessment".
The Patient	The patient may need to attend on 2 separate occasions, once for the stress test and once for the rest test. The stress test takes about 2 to 3 hours and requires strict preparation, including withdrawal from certain medication and caffeine.
Radiation Dose to Patient	11 mSv from the administered dose of 80 MBq. (Tl201 stress/redistribution protocol) 6 mSv from the administered dose of 40 MBq. (Tl201

	rest/reinjection protocol if needed)
Comments	Patients in LBBB should be chemically stressed
References	NICE guidelines: CG 95 (2010) Chest Pain of recent onset CG94 (2010) Unstable Angina and NSTEMI TA73 (2003) Angina and Myocardial Infarction – Myocardial Perfusion Scintigraphy SNM Procedure Guidelines for Myocardial Perfusion Imaging 3.3 (2008) EANM/ESC Procedural Guidelines for Myocardial Perfusion Imaging in Nuclear Cardiology. Eur. J. NMMI. Vol.32, No. 7, (2005) BNMS Procedure Guidelines for Radionuclide Myocardial Perfusion Imaging (2003) Lavalaye JM, Schroider-tanka JM et al. (1997) implementation of technetium-99m MIBI SPECT imaging guidelines: optimising the two-day stress protocol. International Journal of Cardiac Imaging (13(4): 331-51 Aug Pete Shackett (1999) Nuclear Medicine Technology - Procedures and Quick Reference. Lippincott Williams and Wilkins

Cardiac Blood Pool Scintigraphy

Title of Investigation	**MUGA Scan (MUlti Gated Acquisition)** **(Also known as Radionuclide Cardiac Ventriculogram)**
Background	This study is performed for the clinical evaluation of ventricular function. Following the in-vivo labelling of red blood cells with Tc99m, using a stannous agent, a dynamic sequence of images is acquired, showing the cardiac blood pool at different times of the cardiac cycle. Assesses left ventricular contraction in those who have cardiac disease or who are receiving potentially heart damaging medication for malignant disease.
Clinical Indications	Assessment of Left Ventricular Ejection Fraction (LVEF) in patients undergoing cardiotoxic drug therapy Assessment of Left Ventricular Systolic function in patients with heart disease. In either case, if stated on the request, the study can be tailored to assess right ventricular function.
Contra Indications	Pregnancy and Breast feeding. Patient experiencing chest pain. Patient in an unstable medical condition. Patient with known severe arrhythmia. Patient known to be allergic to pyrophosphate or phosphates.
Method and Characteristics	An assessment of LVEF is given, along with qualitative information in relation to wall motion. In those with heart disease, assessment of the right ventricle will also be performed.
The Patient	Two injections are given, 20-30 minutes apart. The subsequent imaging may take up to 30 minutes. If the referral is from a cardiologist we will perform assessment of the right ventricle, which may prolong the study to 45 mins.
Radiation Dose to Patient	5 mSv from an administered dose of 750 MBq.
Comments	
References	NICE guidance: CG80 (2009) Early and locally advanced breast cancer: diagnosis and treatment (replaces TA107 below) TA107 (2007) Trastuzumab for the adjuvant treatment of

	early stage HER2-positive breast cancer BNMS Procedure Guideline for Planar Radionuclide Cardiac Ventriculogram for the Assessment of Left Ventricular Systolic Function (2008). Society of Nuclear Medicine Procedure Guideline for Gated Equilibrium Radionuclide Ventriculography version 3.0, approved June 15, 2002 Pete Shackett (1999) Nuclear Medicine Technology - Procedures and Quick Reference. Lippincott Williams and Wilkins Thralll J.H, Zeissman H A, (1994) The Requisites Nuclear Medicine. Mosby-year book, Inc.

SKELETAL SYSTEM

Bone Scintigraphy

Title of Investigation	Bone Scan
Background	The radiopharmaceutical adsorbs on newly formed bone, and can show areas of varying uptake long before a change is discernable on a radiograph. In principle, may be indicated whenever skeletal pathology is suspected, as outlined below.
Clinical Indications	There are a wide range of clinical indications, this list is not exhaustive. Bone tumours – benign and malignant Identification/staging and monitoring of bone metastases Infection/Inflammation – including the assessment of joint replacements, septic arthritis and osteomyelitis Aseptic Necrosis, including Legg–Calve–Perthes disease Assessment of post traumatic injury, whether stress fracture, occult fracture or complex regional pain disorder. Other clinical situations in Paediatrics
Contra Indications	Pregnancy (Depending on clinical indication, must be discussed with consultant radiologist or nuclear medicine staff)
Method and Characteristics	Increased uptake occurs at the majority of metastases, at many primary bone tumours, at the site of fine fractures, in osteomyelitis and in Paget's disease.
The Patient	There are a range of patient protocols dependent on the indication. Often, the patient is injected with the radiopharmaceutical and returns 2-4 hours later for imaging. For the assessment of infection/inflammation, imaging at the time of injection will be required. The patient needs to lie still for at least 30 minutes (and maybe up to 60 minutes).
Radiation Dose to Patient	3 mSv from an administered dose of 600 MBq. 4 mSv from an administered dose of 750 MBq (SPECT)
Comments	Clinical situations where bone scan may not be useful include: - Osteoporosis (unless for identification of an acute fracture) - Multiple Myeloma
References	Thrall J H, Zeismann H A, eds Nuclear Medicine The Requisites, Mosby 1995

PULMONARY SYSTEM

Lung Scintigraphy – VQ scan

Title of Investigation	Lung Scan / VQ
Background	The single most important application of pulmonary scintigraphy is the evaluation of patients with suspected pulmonary embolism (PE).
Clinical Indications	Suspected acute PE. VQ is indicated in cases of high clinical probability for PE and/or positive D-dimer AND If under 50 or severe renal impairment or in any patient with IV contrast allergy AND Normal Chest X-ray NB: please refer to UHDB guidelines "Pulmonary Embolus – Assessment and Imaging – Suspected Acute PE – Full Clinical Guideline Reference: CG-T/2013/051 The assessment of chronic PE and/or pulmonary hypertension upon referral by respiratory physicians or cardiologists alone. Quantification studies for pre-operative assessment prior to thoracic surgery.
Contra Indications	Absolute: None Relative: Although PE is common in pregnancy and post-partum, ensure the NM staff are informed. It may change how the study is performed; and if the patient is breastfeeding, milk expression will be required.
Method and Characteristics	Works on the premise that pulmonary ventilation and perfusion should be matched. Ventilation and perfusion scans are performed, and the identification of mismatched defects may be used in the diagnosis of pulmonary embolism.
The Patient	It is preferable for both ventilation and perfusion parts of the study to be completed on the same attendance. For the ventilation study, patients need to be able to tolerate a close fitting mouthpiece and nose clip and follow instructions.
Radiation Dose to Patient	1.9 mSv accumulative dose (From 40MBq for ventilation study and 120 MBq for full adult perfusion dose)
Comments	The study should preferably be done within 24 hours of an embolus first being considered.

References	Pulmonary Embolus - Assessment and Imaging - Suspected Acute PE Full Clinical Guideline, Reference No: CG-T/2013/051, DHFT 2013 EANM guidelines for ventilation/perfusion scintigraphy Parts 1 & 2. Eur J Nucl Med Mol Imaging (2009) 36. Bajc et al. Comprehensive Ventilation/Perfusion SPECT. J Nucl Med (2001) 42:1288 – 1294. Palmer et al.

INFECTION AND INFLAMMATION

White Cell Labelling

Title of Investigation	Ceretec /HMPAO/White Cell Investigation
Background	White cells may be labelled in vitro with either Tc99m or In111 for the study of infection and inflammation. The uptake mechanism is specific migration to the site of inflammation. Following reinjection of the labelled white cells, imaging is carried out to image the site of infection/inflammation. Images may be limited to the site of such e.g. abdominal region, or of the whole body. SPECT and CT imaging may also be employed.
Clinical Indications	Inflammatory Bowel Disease Acute soft tissue and abdominal sepsis Osteomyelitis (often in conjunction with Tc99m MDP bone scan) Fever of Unknown Origin (FUO)
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff. The study should not be performed immediately after a barium contrast study since attenuation artifacts may result and cause a false negative study.
Method and Characteristics	Blood is withdrawn from the patient and the white blood cells labelled with the radionuclide (in vitro). Imaging with Tc99m is usually performed at 1 hour and 3 hours post re-injection. Tc99m HMPAO normally accumulates in the liver, spleen, bone marrow, kidneys and gastrointestinal tract. It is therefore suboptimal for detection of lesions in the spleen, and liver. Uptake in inflamed bowel is typically well localized within 1h of injection, before intestinal excretion begins. Generally there should be an increased uptake of leucocytes within the area of interest between the first and second set of images.
The Patient	**Good venous access is required.**
Radiation Dose to Patient	Tc99m ”Ceretec”/HMPAO/White cell: 2 mSv from 200MBq In111 Leucocyte: 7 mSv from 20MBq
Comments	We perform Tc99m Ceretec/HMPAO White cell imaging. Currently In111 labelled white cell studies are not available at this centre; they would only be provided if there was an international shortage of Tc99m.

	Rarely, the test will need to be repeated if labelling is unsuccessful.
References	Hughes D.K. et al (2003). Nuclear Medicine and Infection Detection: The relative effectiveness of Imaging with In111 Oxine, Tc99m HMPAO and Tc99m Stannous fluoride Colloid lablled leukocytes and with Ga67 Citrate. J Nucl Med Technol. Vol 31:196-201. Bayne V.J et al, (1989): Use of sodium iodide to overcome the eluate age restriction for Ceretec reconstitution, Nuclear Medicine Communications, 10, p29 Cox and Buscombe eds The Imaging of Infection and Inflammation; Developments in Nuclear medicine volume 31. .Kluwer Academic Publishers Weldon M, Maxwell D, (1998). Clinical applications of white cell scanning in inflammatory bowel disease. Gastroenterology vol 17 No 2 Charron M., (1997) Inflammatory bowel disease in paediatric patients, The quarterly journal Nuclear Medicine vol 41 309-20.

Gallium (Ga67- citrate)

Title of Investigation	Gallium Scan
Background	Ga67 citrate, as an iron analogue, binds to transferrin, then uses transferrin receptors to access cells, where it becomes highly stable. It effectively labels macrophages. It is extravasated at sites of inflammation because of increased vascular permeability and then transferred to locally present lactoferrin. A combination of Whole Body, SPECT and CT Imaging is usually performed.
Clinical Indications	Chronic infectious processes including osteomyelitis (often in conjunction with Tc99m MDP bone scan) Location of source of fever in patients with FUO Ga67 is non specific and, in addition to assessment of sepsis, it can often localize alternative causes for FUO such as connective tissues disease or underlying malignancy. It can be used to search for the site of unknown primary in cases of known malignancy (CUP).
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff but is unlikely to be performed It is not advised for the investigation of inflammatory bowel disease, as the normal excretion through the bowel can lead to false positives.
Method and Characteristics	Lactulose is administered at the time of injection. Imaging is usually performed at 48 and 72 h, but early imaging may be required to avoid extensive bowel activity. Ref FUO: Delayed imaging necessary to allow radiopharmaceutical to clear from the background Initial excretion through urinary system (25% in first 24 h), then subsequently through the colon. 75% retained in liver, bone, bone marrow and soft tissues at 48h. Normal accumulation in liver, spleen, gastrointestinal tract and kidneys. Non specific uptake seen in several tumours.
The Patient	Given the length of the study, any potential difficulties need to be highlighted, particularly with regard to urinary or faecal incontinence. Information on recent hemolysis/blood transfusion, surgery, trauma, chemotherapy or radiotherapy may be relevant to the interpretation of the images.
Radiation Dose to Patient	Ga67 : 15 mSv from 150MBq

Comments	
References	SNM Procedure Guideline for Gallium Scintigraphy in Inflammation Version 3.0 app 2004

TUMOURS

Adrenal Tumour Scintigraphy

Title of Investigation	MIBG scan – Tumour Imaging
Background	Metaiodobenzylguanidine (mIBG) was developed to visualize tumours of the adrenal medulla. MIBG enters neuroendocrine cells by an active uptake mechanism via the epipherine transporter and is stored in the neurosecretory granules, resulting in a specific concentration in contrast to cells of other tissues. It can be labelled with either I123 or I131. Whole Body, SPECT and CT images may be acquired.
Clinical Indications	The detection, localization, staging and follow up of neuroendocrine tumours including pheochromocytomas, neuroblastomas, ganglioneuroblastomas, ganglioneuromas, paragangliomas, carcinoid tumours, medullary thyroid carcinomas. The evaluation of tumour uptake in preparation for mIBG therapy and monitoring the tumour response to therapy.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff. Should not be used as an initial screening test.
Method and Characteristics	Imaging is normally performed 24h post injection.
The Patient	Prior to imaging with I123, the uptake of any free Iodine in the thyroid must be minimised by a blocking agent. This will be arranged by the Nuclear Medicine department. Many classes of drugs are known to interfere with the uptake of mIBG and may need to be stopped for an adequate period prior to injection. This may cause a delay before we can perform the study.
Radiation Dose to Patient	mIBG I123: 5 mSv from 400MBq
Comments	
References	Shapiro B, Copp J, Sissons C, et al (1985). Iodine -131 Meta-Iodobenzylguanidine for the locating of suspected pheochromocytoma; Experience in 400 cases. The Journal of Nuclear Medicine Vol. 26 pp 576-585. Sisson C, Shapiro B, Beierwaltes W, Copp J (1984). Locating pheochromocytomas by scintigraphy using ^{131}I Meta-Iodobenzylguanidine, Cancer Journal for Clinicians, Vol. 34, No. 2, pp 86- 92. Bombardieri E et al. (2010) I123/I131 mIBG Scintigraphy: procedure guidelines for tumour imaging

	(EANM)

Octreotide/Somatostatin Receptor Tumour Scintigraphy

Title of Investigation	Tektrotyd
Background	Tc99m Tektrotyd (EDDA/HYNIC-TOC) is a radiopharmaceutical indicated for the diagnosis of tumours with over expression of somatostatin receptors. It labels type 2 receptors, which are over expressed in the majority of neuroendocrine tumours such as carcinoid and can assist in neuoroectodermal tumours such as Phea if mIBG negative. In111 Octreotide remains an alternative. Tc99m – Tektrotyd Whole Body, SPECT and CT images may be acquired.
Clinical Indications	The detection, localization, staging and follow up of neuroendocrine gastro-entero-pancreatic (GEP) tumours and their metastases.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff. Should not be used as an initial screening test.
Method and Characteristics	Partial wholebody and SPECT imaging is performed at 4h post injection.
The Patient	Octreotide treatment may need to be stopped prior to the test. This will be given consideration when scheduling the test.
Radiation Dose to Patient	Tektroyd Tc99m: 4 mSv from 740MBq
Comments	
References	M. Gabriel et al (2005) “Tc99m–EDDA/HYNIC-Tyr(3) – octreotide for staging and follow up of patients with neuroendocrine gastro-entero-pancreatic tumours”. Q J Nucl Med Mol Imaging; 49:237-44.

Thyroid Tumour Scintigraphy

Title of Investigation	Iodine I131 Whole Body
Background	Radioactive Iodine (I131) may be used post-operatively in patients with differentiated thyroid cancer for diagnostic whole body scanning. In conjunction with serum Tg measurements, it may be used to assess treatment success and/or to monitor for disease recurrence. Routine follow-up at 12 months post-ablation is now generally performed using stimulated Tg measurement and neck ultrasound.
Clinical Indications	Follow up diagnostic scan following treatment for differentiated thyroid cancer with I131. Evaluation of tumour response to therapy Tumour uptake to plan radionuclide therapy treatment.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	Imaging is performed at 48h post administration of I131 capsule.
The Patient	Thyrogen is routinely used in preparation for the test. This removes the requirement for T4 and T3 to be stopped prior to the test (4 weeks and 2 weeks respectively).
Radiation Dose to Patient	I131: 25 mSv from 150 MBq
Comments	
References	BTA Guidelines for the Management of Thyroid Cancer (2014) Clinical Endocrinology Vol 81 Supp 1. British Thyroid Association and Royal College of Physicians (2007) “Guidelines for the management of thyroid cancer”. M. Luster et al. (2008) “Guidelines for radioiodine therapy of differentiated thyroid cancer.” Eur J Nucl Med Mol Imaging; 35 (10):1941-59.

Thyroid Tumour Scintigraphy

Title of Investigation	Iodine I123 Whole Body
Background	Radioactive Iodine (I131) has traditionally been used post operatively in patients with differentiated thyroid cancer for diagnostic whole body scanning. This may be as part of monitoring for disease recurrence, prior to ablation of remnant thyroid tissue or treatment for recurrent or metastatic disease. The use of I123 rather than I131 avoids the potential "stunning" effect of I131, which may render subsequent treatment with I131 ineffective.
Clinical Indications	Tumour uptake to plan radionuclide therapy treatment. Evaluation of tumour response to therapy Eliminates potential stunning effect when I131 used for diagnostic scanning. If clinical suspicion of localised recurrence, U/S with FNA may be appropriate as well.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	Imaging is performed at 24h post injection.
The Patient	Thyrogen is routinely used in preparation for the test. This removes the requirement for T4 and T3 to be stopped prior to the test (4 weeks and 2 weeks respectively).
Radiation Dose to Patient	I123: 8 mSv from 400 MBq (For Thyroid Cancer patients who have previously had an I131 Ablation)
Comments	
References	Alzahrani A. et al. (2001) "I123 Isotope as a diagnostic agent in the follow-up of patients with differentiated thyroid cancer: comparison with post I131 therapy whole body scanning". Q J Clin End & Met; 86(11):5294-5300. Shankar LK et al. (2002) "Comparison of I123 scintigraphy at 5 and 24h in patients with differentiated thyroid cancer." J Nucl Med. 43(1):72-76. M. Luster et al. (2008) "Guidelines for radioiodine therapy of differentiated thyroid cancer." Eur J Nucl Med Mol Imaging; 35 (10):1941-59.

Tc99m PSMA Scintigraphy

Title of Investigation	PSMA scan – Tumour Imaging
Background	PSMA (Prostate Specific Membrane Antigen, Glutamate carboxypeptidase II) is expressed by well over 90% of all prostate cancers on the cell membrane. It is actually neither specific or limited to prostate cancer but is often over-expressed hundred fold or more in this compared to benign prostate or other tissues. It is also expressed in neovascularity of other tumours. The current analogues for both PET and SPECT imaging label the extracellular portion of the transmembrane receptor. Tc99m PSMA analogues perform better than F-18 choline and appear comparable to the Ga68 (PET) PSMA analogues when in biochemical recurrence PSA is >2 ng/ml or >2 + nadir post radiotherapy. Similar performance comparable to PET analogues is also seen in the context of primary staging in patients with PSA >30ng/ml, when currently in absence of extra-prostate disease on conventional imaging; ideally using Choline or Ga68 PSMA for patients with <30 ng/ml, unless the patient is frail. Whole Body, SPECT and CT images may be acquired.
Clinical Indications	1. Biochemical recurrence of carcinoma prostate in the following situations: • when PSA >2 ng/ml • post-radiotherapy >2+nadir. • in the frail patient (i.e. unable to travel for PET/CT) where PSA>0.5 or post radiotherapy >0.5+nadir PSA must be provided on request 2. Primary staging for query distant deposits when conventional imaging CT and bone scan negative and PSA > 30 ng/ml as per optimal pathway (although Prostate Cancer UK suggests an upper threshold of intermediate risk of 20 ng/ml) GS and PSA must be provided on request 3. In known metastatic disease, determination as to if Lu-177 PSMA would be effective https://www.england.nhs.uk/wp-content/uploads/2018/04/implementing-timed-prostate-cancer-diagnostic-pathway.pdf

Contra Indications	Male patients only so pregnancy should not be an issue
Method and Characteristics	Imaging is performed at 3 to 4 hours post-injection
The Patient	No preparation is required
Radiation Dose to Patient	PSMA Tc99m: 6.5 mSv from 750 MBq
Comments	
References	**Tc99m PSMA MIP 1404 Dosimetry** Vallaghajosula et al (2014) Tc99m-labelled small-molecule inhibitors of Prostate-Specific Membrane Antigen: pharmokinetics and biodistribution studies in healthy subjects and patients with metastatic prostate cancer. J Nucl Med. Vol. 55 pp1791-1798. http://jnm.snmjournals.org/content/55/11/1791.long accessed 22 December 2020. **Primary staging of prostate cancer** Goffin et al (2017) Phase 2 Study of Tc99m-Trpfplastat SPECT/CT to identify and localise prostate cancer in intermediate and high risk patients undergoing radical prostatectomy and extended pelvic LN dissection. J Nucl Med. Vol. 58 pp1408-1413. https://www.ncbi.nlm.nih.gov/pubmed/28302763 accessed 22 December 2020. Schmidkonz et al (2018) SPECT/CT with the PSMA ligand Tc99m-MIP-1404 for whole body primary staging of patients with prostate cancer. Clin Nucl Med. Vol. 43(4) pp225-231. https://www.ncbi.nlm.nih.gov/pubmed/29401151 accessed 22 December 2020 **Biochemical recurrence** Reinfelder et al (2017) First experience with SPECT/CT using a Tc99m-labelled inhibitor for Prostate-Specific Membrane Antigen in patients with biochemical recurrence of prostate cancer. Clin Nucl Med. Vol. 42(1) pp26-33. https://www.ncbi.nlm.nih.gov/pubmed/27775936 accessed 22 December 2020. Schmidkonz et al (2020) Tc99m-MIP-1404 SPECT/CT for assessment of whole body tumour burden and treatment response in patients with biochemical recurrence of prostate cancer. Clin Nucl Med. 45(8) e349-e357. https://pubmed.ncbi.nlm.nih.gov/32558706 accessed 22

	December 2020. Schmidkonz et al (2018) Tc99m-MIP-1404 SPECT/CT for the detection of PSMA-positive lesions in 225 patients with biochemical recurrence of prostate cancer. Prostate. Vol. 78(1) 54-63. https://www.ncbi.nlm.nih.gov/pubmed/29105797 accessed 22 December 2020. Werner et al (2020) Tc99m-PSMA-I&S SPECT/CT: experience in prostate cancer imaging in an outpatient center. EJNMMI Res 10:45. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7205926 accessed 22 December 2020. **For comparison of how F-18 choline and PET PSMA analogues perform in BCR.** Evans et al (2018) Prostate cancer-specific PET radiotracers: A review on the clinical utility in recurrent disease. Practical Radiation Oncology Vol 8(1) p28-39. https://www.practicalradonc.org/article/S1879-8500(17)30206-0/abstract accessed 22 December 2020. **Assessment of metastatic disease** Schmidkonz et al (2020) Tc99m –MIP-1404 SPECT/CT for assessment of whole body tumour burden and treatment response in patients with biochemical recurrence of Prostate Cancer. Clin Nucl Med 45 (8) e349-e357. https://pubmed.ncbi.nlm.nih.gov/32558706 accessed 22 December 2020. Scmidkonz et al (2020) Tc99m-MIP-1404 SPECT/CT for patients with metastatic prostate cancer: Interobserver and Intraobserver variability in treatment-related longitudinal tracer uptake assessments of Prostate Specific Membrane Antigen-positive legions. Clin Nucl Med 45 (2) 105-112. https://www.ncbi.nlm.nih.gov/pubmed/31876822 accessed 22 December 2020

GASTROINTESTINAL TRACT

Hepatobiliary Scintigraphy

Title of Investigation	HIDA Scan
Background	HIDA is excreted into the bile by the liver in high concentrations. HIDA compounds are accumulated into the gallbladder and excreted into the small bowel, enabling a measurement of gallbladder ejection fraction to be made, along with an assessment of any obstruction, leakage or contraction problems.
Clinical Indications	Evaluation of cholecystitis; inflammation of gallbladder, cystic or common bile ducts. Sphincter of Oddi dysfunction (SOD). Detection of biliary leak Post-operative assessments of stents, cholecystectomy and anastomosis of bile duct to jejunum
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff. Patients who have not fasted Patients who have fasted for more than 24 hours Administration of morphine (or other opiates) within hours of the study
Method and Characteristics	The liver, hepatic ducts, gallbladder and bile ducts may be visualised. Acute cholecystitis is generally due to cystic duct obstruction; visualization of the gallbladder virtually excludes the diagnosis of acute cholecystitis. Poor contraction of the gallbladder in patients with chronic pain and normal ultrasound is the feature of gallbladder dyskinesis. The cardinal feature of SOD, often post cholecystectomy, is increasing activity in the biliary tree post fatty meal. This reflects the spasm of the sphincter.
The Patient	Patient needs to fast for 6 hours before the investigation. The study involves drinking a milkshake and a glass of water whilst lying down. The patient needs to remain still during imaging for 1 hour.
Radiation Dose to Patient	0.8 mSv from an accumulative dose of 52 MBq.
Comments	The milkshake stage of the test may be omitted e.g. in cases of nut allergy or extreme discomfort.
References	Hepatobiliary Scintigraphy- BNMS Clinical Guidelines, 2015

	James Thrall, Harvey Ziesman, Nuclear medicine the requisites (1995) Mosey, Missouri. Chapter 9 hepatobiliary System Bernier, D.R., Christian, P.E., and Langan, J.K. (eds.) Nuclear Medicine Technology and Techniques. 3rd ed. Mosby, Missouri. Tulchinsky M. et al (2010). SNM Practice guideline for Hepatobiliary Scintigraphy 4.0. JNMT:38(4);210-218.

Liver and Spleen Scintigraphy

Title of Investigation	**Liver/Spleen Scan**
Background	Liver and spleen imaging using radio-labeled tin colloid. It is used in the assessment of potential focal nodular hyperplasia (FNH) and if there is residual splenic tissue in Immune Thrombocytopenia (ITP) post splenectomy. It may be used in the assessment of potential accessory splenic tissue in pancreatic tail/splenic hilum.
Clinical Indications	Provides information about the function, shape, size and position of the liver and spleen. It is useful to differentiate between FNH and other solitary hepatic regions over 1cm in size. Detection of residual splenic tissue post splenectomy in ITP.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	The colloid distributes uniformly in normal liver and spleen. The presence of increased uptake would confirm FNH. In ITP, focal uptake reveals residual splenic tissue, while localized reduced uptake can be due to tumours, cysts or abscesses.
The Patient	No patient preparation is required. The study should not be performed immediately after a barium contrast study since attenuation artifacts may result.
Radiation Dose to Patient	0.7 mSv from an administered dose of 80 MBq. (Liver - Planar) 1.1 mSv from an administered dose of 120 MBq (Liver – SPECT) 1.8 mSv from an administered dose of 200 MBq (Splenic Tissue, partial wholebody and SPECT)
Comments	Consultant referral only.
References	Society of Nuclear Medicine Procedure Guideline for Hepatic and Splenic Imaging 3.0, approved 2003. Horger M, Eschmann S, Lengerke C, Pfannenberg C, Bares R. Improved detection of Splenosis in patients with Haematological disorders: the role of combined transmission-emission tomography. EANM Vol. 30, No. 2, Feb 2003. Nuclear medicine the requisites 1995 Mosey, Missouri Chapter 9 Hepatobilary System

Gastrointestinal Bleed

Title of Investigation	G.I.Bleed
Background	The investigation of intestinal bleeding using Tc99m-labelled red blood cells (RBC). Sites of active bleeding are identified by the accumulation and movement of labelled RBC within the bowel lumen. It is a relatively non invasive and sensitive test for the detection of a GI bleed.
Clinical Indications	Location of the site of active bleeding in the intestinal tract, to assist with treatment planning and/or surgical intervention. This investigation is usually done when endoscopy with/without CT angiography fails to reveal the site of bleeding.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff. Patients known to be allergic to pyrophosphate or phosphates. Relative contraindication - recent barium study
Method and Characteristics	In positive cases, a focal area of increased activity may be identified corresponding to the site of the bleeding.
The Patient	Two injections are given. Imaging lasting for 70 minutes is performed after the second injection. Subsequent images of approximately 10 minutes each are also acquired several hours later and again the following day.
Radiation Dose to Patient	3 mSv from an administered dose of 400 MBq.
Comments	The technique requires blood loss to be greater than about 1 ml per minute i.e. the patient must be actively bleeding at the time of the investigation to produce a positive scan.
References	Nuclear medicine the requisites 1995 Mosey, Missouri Chapter 10 Gastrointestinal System The SNMMI Procedure Standard/EANM Practice Guideline for Gastrointestinal Bleeding Scintigraphy 2.0 (2014) JNMT 42 (4).

Meckel's Diverticulum Scan

Title of Investigation	Meckel's Scan
Background	A Meckel's diverticulum is a vestigial remnant of the omphalomesenteric duct located on the ileum about 50 to 80 cm from the ileocecal valve. Tc-99m pertechnetate avidly accumulates in the gastric mucosa that many Meckel's diverticuli contain, enabling its location to be visualised. Most patients referred for this test are young.
Clinical Indications	The localization of ectopic gastric mucosa in a Meckel's diverticulum as the source of unexplained gastrointestinal bleeding.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff. Patients who are actively bleeding – consider GI bleed study instead.
Method and Characteristics	A series of images are acquired over a period of approximately 1 hour.
The Patient	Fasting is necessary for 4 hours prior to the scan. Pre-treatment with Cimetidine is performed to increase gastric mucosa uptake. The study should not be performed immediately after a barium contrast study since attenuation artifacts may result.
Radiation Dose to Patient	5 mSv from an administered dose of 400 MBq.
Comments	
References	Nuclear medicine the requisites 1995 Mosey, Missouri Chapter 10 Gastrointestinal System **SNMMI and EANM Practice Guideline for Meckel Diverticulum Scintigraphy 2.0. JNMT (2014) Vol. 42 no. 3 163-169**

SeHCAT Scintigraphy

Title of Investigation	SeHCAT
Background	SeHCAT (a Selenium-75 labelled synthetic bile salt conjugate) is a recognized investigation in the diagnosis of bile acid malabsorption. There are acknowledged to be 3 main types of Bile Acid Malabsorption: - Following resection or abnormality of the ileal mucosa (e.g. Crohn's) - Primary idiopathic malabsorption - Associated with cholecystectomy, vagotomy and certain drugs.
Clinical Indications	Diarrhoea present. Cholecystectomy Vagotomy Weight loss.
Clinical situation where not useful	In the following circumstances, Sehcat is likely to prove non contributory, as one would expect it to be abnormal: post right hemicolectomy and post resection of the terminal ileum. These requests will be declined.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff. No Barium studies to have been performed for 1 week prior to the test or at any point during the test.
Method and Characteristics	SeHCAT is administered orally and the percentage absorption is measured after 1 week.
The Patient	The patient needs to attend on two separate occasions, 1 week apart.
Radiation Dose to Patient	0.3 mSv from an administered dose of 0.37 MBq.
Comments	
References	Summers JA et al. Multicentre prospective survey of SeHCAT provision and practice in the UK. BMJ Open Gastro 2016;3:e000091. doi:10.1136/bmjgast-2016-000091 Smith MJ and Perkins AC (2013). A survey of the clinical use of SeHCAT in the UK. NMC 34(4). Notghi, A. et al (2011) Measuring SeHCAT retention: a technical note. NMC. 32(10): 960-966. Merrick, M.V. et al. (1985) Is bile acid malabsorption under diagnosed? BMJ Vol 290:665-669.

Colonic Transit

Title of Investigation	Colonic Transit
Background	Prolonged colonic transit can be caused either by slow transit constipation or by pelvic outlet obstruction. A differential diagnosis is important in defining an appropriate treatment regime. A colonic transit study is a recognized investigation in the diagnosis of colonic motility disorders, enabling total and segmental transit times to be determined.
Clinical Indications	Idiopathic constipation Slow colonic transit Colonic motility Post abdominal surgery
Clinical situation where not useful	Assessment of rapid transit Small bowel motility assessment
Contra Indications	
Method and Characteristics	The In111 is administered orally by means of a "milkshake drink". A series of images are acquired over several days. Initial images are acquired 6 hours post injection, and then on daily visits over the next 4 days.
The Patient	The patient will be required to make several visits to the Nuclear Medicine department over a period of 4 days. Medication for constipation should be stopped 3 days before the test and restarted after the final day of the test. This must be agreed with the referring physician. On the morning of the test the patient should just have a light breakfast. The patient can eat and drink as normal for the rest of the test. The patient will need to complete a bowel movement chart during the period of the study.
Radiation Dose to Patient	2 mSv from an administered dose of 5 MBq.
Comments	
References	The SNMMI and EANM Practice Guideline for Small-Bowel and Colon Transit 1.0, AH Maurer et al. JNM, Vole 54, No 11, 2013, p. 2004 A Notghi Chapter 21: Gastrointestinal Tract in: Nuclear Medicine in Radiological Diagnosis. Ed: A M Peters. 2003

Gastric Emptying

Title of Investigation	Gastric Emptying
Background	Radionuclide studies of gastric emptying and motility offer a physiological method of studying gastric motor function. Following consumption of a radioactive labelled meal, the movement of liquids and solids through the gastrointestinal tract may be visualized.
Clinical Indications	Determination of gastric emptying with quantification of gastric emptying rate Assessment of mechanical obstruction Evaluation of altered function e.g. gastroparesis Investigation of nausea, vomiting, abdominal bloating
Contra Indications	Pregnancy
Method and Characteristics	Imaging is performed immediately after the meal is consumed and then subsequently at various intervals of time over the next 2-3 hours. There are numerous images, but each is relatively quick. There must be no eating or drinking throughout this period of time. The meal is usually a “Cottage Pie” (919 calories per pack), but other options are available according to dietary requirements e.g. vegetarian, vegan and liquid etc.
The Patient	The patient is required to fast for 4 hours prior to the test. The radioactive meal must be eaten in its entirety within 10 minutes followed by drinking 50ml water. Drugs affecting gastric emptying may need to be stopped, at the discretion of the referring clinician.
Radiation Dose to Patient	0.3 mSv from 12 MBq (Tc99m-DTPA/MAA/Colloid labelled meal)
Comments	
References	BNMS Gastric Emptying Guideline 2014 *https://www.bnms.org.uk/bnms-clinical-guidelines/gastric-emptying-guideline.html* Procedure Guideline for Adult Solid-Meal Gastric-Emptying Study 3.0, K J Donohoe et. al. SNM, February 8 2009 A Notghi Chapter 21: Gastrointestinal Tract in: Nuclear Medicine in Radiological Diagnosis. Ed: A M Peters. 2003

Oesophageal Scintigraphy

Title of Investigation	Oesophageal Transit (Reflux and/or Aspiration)
Background	A drink of orange juice is labelled with (radioactive) Tin colloid, enabling its passage through the oesophagus to be visualized. The images acquired will enable any blockages or regions of slower movement to be identified, along with the occurrence of reflux. The oesophageal transit time may also be assessed. In this way, scintigraphy provides a physiological, quantitative, non invasive evaluation of suspected oesophageal motility disorders prior to medical or surgical treatment.
Clinical Indications	To assess for silent pulmonary aspiration. Evaluation of oesophageal sphincter dysfunction. Evaluation of dysphagia and decreased oesophageal motility attributed to achalasia. Evaluation of clinical management by monitoring for serial changes or response to therapy. Investigation of neuromuscular and connective tissue disorders involving the oesophagus.
Contra Indications	
Method and Characteristics	Dynamic images are acquired whilst the patient swallows the orange juice and for the following 45 minutes, to assess if there is early reflux Delayed imaging is also performed at 4 and 24 h to assess if there has been interval aspiration.
The Patient	The patient will be required to fast for 4 hours prior to the study. Medications affecting oesophageal motility may need to be stopped.
Radiation Dose to Patient	0.5 mSv from 20 MBq
Comments	
References	ACR–SNM-SPR Practice Guideline for the Performance of Gastrointestinal Scintigraphy. Revised 2010. A Notghi Chapter 21: Gastrointestinal Tract in: Nuclear Medicine in Radiological Diagnosis. Ed: A M Peters. 2003

GENITOURINARY SYSTEM

Dynamic Intravenous studies of the renal system

Title of Investigation	Renogram Scan (DTPA or MAG3)
Background	Renography is a diagnostic imaging study that evaluates divided renal function, including renal transit and clearance to the bladder. Both Tc99m DTPA and MAG3 may be used. DTPA is cleared from the blood solely by glomerular filtration, enabling it to be used for the measurement of GFR; whilst MAG3 is also secreted through the tubules so an assessment of GFR is not possible. A measurement of effective renal plasma flow is possible, however.
Clinical Indications	Identification/monitoring of PUJ obstruction, along with post surgical evaluation Estimate of glomerular filtration rate (GFR) (DTPA only) Assessment of differential renal function. Investigation of renovascular hypertension Indirect micturating cystogram for reflux (MCUG).
Contra Indications	Pregnancy (Relative contraindication – please discuss with consultant radiologist or nuclear medicine staff. A MAG3 study would be performed.)
Method and Characteristics	Frequent dynamic images are obtained over a period of about 20 minutes. Glomerular filtration rate and divided kidney function are calculated. The individual images provide information about the kidney anatomy, the ureters and bladder.
The Patient	The patient needs to be well hydrated. The patient needs to remain very still for 20 minutes. A diuretic may be administered during the scan.
Radiation Dose to Patient	DTPA: 2 mSv from 300 MBq MAG3: 0.7 mSv from 100MBq
Comments	If initial imaging was MAG3 at RDH, follow up will be MAG3 and similarly for DTPA. However, if previous imaging performed elsewhere was MAG3, subsequent imaging at RDH is likely to be DTPA. Young adults from urology referrals should be MAG3.
References	BNMS Dynamic Renal Radionuclide Studies (Renography) Clinical Guidelines 2011. EANM Guideline for standard and diuretic renogram in children 2011. EANM guidelines for Indirect Radionuclide Cystography

	Paediatric Task Group European Association Nuclear Medicine Members (1990) “A radiopharmaceutical schedule for imaging paediatrics” European Journal of Nuclear Medicine 17:127-129. Cosgrith P, Lawson R, Nimmon C (1992) “Towards standardisation in gamma camera renography” Nuclear Med.Com.13:580 - 585

Glomerular Filtration Rate (GFR)

Title of Investigation	GFR (with Tc99m DTPA)
Background	GFR is a widely accepted measure of renal function. It is routinely measured using tracers cleared exclusively by glomerular filtration such as Tc99m DTPA in a diagnostic in-vitro study.
Clinical Indications	Assessment of total glomerular filtration rate e.g. prior to and during renal toxic therapy. Assessment of poor renal function (only when an estimate of split function is not needed).
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	This is an in-vitro investigation. The radio-pharmaceutical is physiologically inert and is therefore removed from the blood by free filtration of the glomerulus. Blood samples are taken, and the EDTA/DTPA content is measured.
The Patient	Patient requires IV injection of the labeled DTPA and 3 blood samples taken over the next 4 hours. Good IV access is therefore required.
Radiation Dose to Patient	Tc99m DTPA: 0.05 mSv from an administered dose of 10 MBq
Comments	In cases of suspected PUJ obstruction or where an assessment of differential renal function is required a DTPA plasma sampling study is not useful. A renogram with DTPA or MAG3 may be considered as an alternative.
References	Burniston M (2018) Clinical Guideline for the measurement of glomerular filtration rate (GFR) using plasma sampling. Report 2018 replaces 2004 guideline. J.M. McAlister Radionuclide Techniques in Medicine (1979) Cambridge University Press A.C. Perkins Nuclear Medicine Science and Safety

Renal Cortical Scintigraphy

Title of Investigation	DMSA Scan
Background	Renal cortical scintigraphy is a diagnostic study that primarily evaluates abnormalities related to urinary tract infections. Untreated reflux and infection can lead to cortical scarring and subsequent chronic renal failure or hypertension. It is also proven to be effective in assessing the nature of an indeterminate renal mass.
Clinical Indications	Confirmation of an episode of acute pyelonephritis, if other assessment is indeterminate and confirmation of such would change management. Assessment for resolution of sequalae of acute pyelonephritis (follow up scan should ideally be arranged 6 months after infection resolved to ensure no renal scaring). Assessment of focal or global renal scarring. Assessment of differential renal function. Detection of ectopic kidneys and abnormalities such as duplex kidney, small kidney, dsyplastic tissue. Confirming non-functional multi-cystic kidneys. Assessment of indeterminate renal mass on anatomical imaging.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	The renal cortex has a high affinity for DMSA; about 50 % of the given dose is taken up by the cortex. High resolution scans can be performed 3.5 to 4 hours after injection. In adults, in addition to planar imaging, SPECT will be performed.
The Patient	No patient preparation is required.
Radiation Dose to Patient	0.7 mSv from an administered dose of 80 MBq
Comments	
References	Paediatric Task Group European Association Nuclear Medicine Members (1990) “A radiopharmaceutical schedule for imaging paediatrics” European Journal of Nuclear Medicine 17:127-129. James Thrall, Harvey Ziesman. Nuclear medicine the requisites 1995 Mosey, Missouri Chapter 12 Genitourinary System EANM Guidelines for Tc99m DMSA Scintigraphy in

	children.

ENDOCRINE SYSTEM

Parathyroid Scintigraphy

Title of Investigation	Parathyroid Scan
Background	Tc99m -Sestamibi is taken up by the thyroid and by hyperactive parathyroid tissue, whereas Tc99m - pertechnetate is taken up by the thyroid only. Sestamibi washes out of the thyroid much quicker than from parathyroid adenoma hence why early and delayed imaging is performed. Parathyroid scintigraphy therefore employs a combination of Tc99m Sestamibi and Tc99m pertechnetate to enable the parathyroids to be distinguished from the thyroid in the images. Scintigraphy is often used in conjunction with ultrasound.
Clinical Indications	Localisation of parathyroid adenomas prior to (unilateral or focused) surgery.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	The Sestamibi injection is given first, with initial imaging 15 minutes later. Delayed imaging is performed at 3 hours, by which time its “washout” will be complete. The patient will then have a technetium (pertechnetate) injection, followed by a final image, Subtraction of this delayed image from the early images will therefore enable the parathyroid glands to be visualised.
The Patient	The patient must be able to lie still for up to 1 hour and will need to attend the Nuclear Medicine department on two separate visits on the same day.
Radiation Dose to Patient	Planar: 6.6 mSv from an administered dose of 750 MBq Sestamibi. 1 mSv from an administered dose of 74 MBq pertechnetate.
Comments	
References	EANM Parathyroid Guidelines 2009. Eur. J. Nucl. Med. Mol. Imaging 36:1201-1216. SNM Practice Guidelines for Parathyroid Scintigraphy 4.0. 2012. Greenspan et al. JNMT Vol.40. No.2. 111-118. Nuclear medicine the requisites 1995 Mosey, Missouri Chapter 13 Endocrine System

Thyroid Scintigraphy

Title of Investigation	Thyroid Scan (Tc99m pertechnetate)
Background	For palpable nodules, ultrasound is the preferred initial method of assessment. If this has not been performed prior to NM imaging the request is likely to be declined. Tc99m pertechnetate, when used for imaging the thyroid gland, is trapped by the thyroid but not organified and only remains in the gland for a short period. Images of the thyroid are acquired and thyroid uptake measurements performed.
Clinical Indications	Assist in the differential diagnosis of hyperthyoidism/thyrotoxicosis Identify whether palpable nodules are functioning once ultrasound has been performed. Generally establish sites of ectopic thyroid tissue. Establish the presence of functional thyroid tissue and congenital hypothyroidism.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	Static images are acquired 15 minutes after injection. The pattern of uptake in thyrotoxicosis can help distinguish Graves' disease from subacute/viral thyroiditis. When nodules post-ultrasound are assessed the presence of a hot nodule is reassuring, the presence of a cold nodule, if solid on US, requires further investigation.
The Patient	Numerous medications may interfere with the uptake of radiopharmaceutical in the thyroid tissue. This includes Carbimazole and Propylthiouacil, which will need to be stopped 3 days prior to the test.
Radiation Dose to Patient	1 mSv from an administered dose of 74 MBq. (In adults)
Comments	A request for a thyroid scan acts as authorization for Carbimazole to be stopped prior to the test.
References	Diagnostic Imaging – Nuclear Medicine. Bennett, Oza et al. 2nd ed. 2016 BNMS Guidelines – Radionuclide Thyroid Scans – Report 2003 SNM Guidelines – Society of Nuclear Medicine Procedure Guideline for Thyroid Uptake Measurement. Version 3.0, approved 2006.

BRAIN

Brain Scintigraphy

Title of Investigation	DaTSCAN / Dopamine Transporter Imaging
Background	DaTSCAN I123 Ioflupane works by binding to dopamine transporters in the brain. It is used in the evaluation of patients with suspected Parkinsonian syndromes (PS) by imaging the uptake in the striatal dopamine transporters. This is reduced in Parkinson's disease.
Clinical Indications	Parkinsonism of uncertain cause, including potentially drug induced.
Contra Indications	Pregnancy
Method and Characteristics	SPECT-CT imaging is performed 4 hours post injection. Additional visit(s) to the department may be required to comply with thyroid blocking procedure. Intense symmetrical uptake in both caudate nuclei and putamen (i.e. the striatum) is normal. Reduced uptake, whether unilateral or bilateral, affecting caudate nuclei and/or putamen, is abnormal.
The Patient	Thyroid blocking is required prior to the study. Numerous medications may interfere with DaTSCAN and may need to be stopped prior to the study.
Radiation Dose to Patient	4.6 mSv from 185 MBq
Comments	Please indicate if there is history of iodine sensitivity.In such instances we would consider withholding the thyroid blocking and giving steroid cover, post discussion with the referrer.
References	Parkinson's Disease Society. DaTSCAN-SPECT Diagnostic Imaging in the Management of Parkinson's Disease. (A consensus report from the Parkinson's Disease Society.) Oxford: Darwin Medical Communications Ltd, 2002. Kemp P. (2006). "Imaging the dopaminergic system in suspected parkinsonism, drug induced movement disorders and Lewy body dementia." NMC:26;87-96

Brain Perfusion Scintigraphy

Title of Investigation	Cerebral Perfusion – Ceretec (HMPAO) Brain SPECT
Background	Tc99m–labelled HMPAO (Exametazime/Ceretec enters brain cells by crossing the blood brain barrier due to its lipophilic nature and remains there due to conversion into hydrophilic compounds.
Clinical Indications	Evaluation of cerebrovascular disease e.g. in acute stroke and SAH. Evaluation of suspected dementia. Evaluation of traumatic brain injury. Evaluation of suspected inflammation/vasculitis. Pre-surgical evaluation of epilepsy to assist with localization of epileptic focus at a neurosurgical centre. Assessment of brain death (upon discussion).
Contra Indications	Pregnancy
Method and Characteristics	SPECT-CT imaging is performed 30 minutes after injection. The images are assessed for relative regional flow differences; for example by comparing asymmetrical uptake between the temporal lobes.
The Patient	The patient must be able to hold their head still for the duration of the scan.
Radiation Dose to Patient	5 mSv from 500 MBq
Comments	
References	Kapucu, OL et al. (2009). EANM Procedure guideline for brain perfusion SPECT using Tc99m-labelled radiopharmaceuticals, version 2. Eur J Nucl Med Mol Imaging 36(12):2093-2102.

LYMPHATIC SYSTEM

Lymphoscintigraphy

Title of Investigation	Lymphogram
Background	Lymphoscintigraphy offers an objective and reliable method to diagnose and characterize the severity of lymphoedema. Tc-99m labelled nanocoll is injected subcutaneously into the webspace. Its transport from the injection site, through the lymphatics, and both the local and regional lymph nodes can then be visualized.
Clinical Indications	Lymphoedema – either primary or secondary Differential diagnosis of lymphoedema from venous edema, myxedema, lipedema, or other etiology.
Contra Indications	
Method and Characteristics	Wholebody imaging is performed at regular intervals for approximately 2 hours following subcutaneous injection. A range of findings can be identified, including interruption of lymphatic flow, collateral lymph vessels, dermal backflow, delayed flow, delayed visualization or non-visualization of lymph nodes, a reduced number of lymph nodes, dilated lymphatics, and in severe cases, no visualization of the lymphatic system at all.
The Patient	Intervals between images may be used for exercise to promote lymphatic drainage
Radiation Dose to Patient	0.2 mSv from 40 MBq
Comments	
References	PS Mortimer Chapter 41: The Swollen Limb in: Nuclear Medicine in Radiological Diagnosis. Ed: A M Peters. 2003 A Madonald and S Burrell. (2008) “Infrequently performed studies in Nuclear Medicine: Part II” JNMT 37(1): 1-13. V Keeley. (2006) “The use of Lymphoscintigraphy in the Management of Chronic Oedema” J of Lymphoedema 1(1):42-57.

Sentinel Node

Title of Investigation	Sentinel Node (including Breast and Vulval studies)
Background	Sentinel lymph node biopsy (SLNB) is commonly performed with the assistance of radioisotope (Tc99m Nanocoll) +/-blue dye. The dye is important in the identification of the first lymph node in a regional lymphatic basin that receives lymphatic flow from the primary tumour.
Clinical Indications	Prior to SLNB (Breast,Vulva)
Contra Indications	
Method and Characteristics	Prior to the SNLB procedure, Tc99m Nanocoll is injected subcutaneously near to the site of the tumour(s). A gamma probe is used in theatre to detect the location of the Nanocoll, which represents the location of the sentinel lymph node.
The Patient	The patient is required to come to the Nuclear Medicine department for the injection, prior to going to theatre for the biopsy.
Radiation Dose to Patient	0.02 mSv from 20 MBq (breast) 0.4 mSv from 60 MBq (vulva)
Comments	Additional information to be provided on the request: • Identify if patient is from QHB or RDH • Date of planned surgery • Date SLNB injection required • R/L breast and location (o' clock) We do not currently perform imaging for breast studies. If imaging is needed please contact the department so that the procedure can be modified.
References	RCOG Guidelines for the Diagnosis and Management of Vulval Carcinoma (2014). EANM and SNMMI practice guideline for lymphoscintigraphy and sentinel node localization in breast cancer (2013). Eur J Nucl Med Mol Imaging. Frumovitz M and Levenback CF (2008). Oncology 22 (5). Lymphatic Mapping and Sentinel Node Biopsy in Vulval, Vaginal and Cervical Cancers. Mansel RE et al. (2006). "Randomized multicenter trial of sentinel node biopsy versus standard axillary treatment in operable breast cancer: the ALMANAC trial". Journal of the National Cancer Institute 98(9):599-609.

OTHER STUDIES

Dacroscintogram

Title of Investigation	Dacroscintogram
Background	Used for defining the patency of the lacrimal duct. The level of functional obstruction can be clearly demonstrated.
Clinical Indications	Assessment of functional obstruction to nasolacrimal drainage system. Post operative evaluation to determine success of surgery.
Contra Indications	Pregnancy – please discuss with consultant radiologist or nuclear medicine staff.
Method and Characteristics	This is a non-invasive test. Using an eye dropper, the radiopharmaceutical is placed onto the lower eyelid, and images are immediately performed. Normal images should show radioactivity in the area of the nose within ten to fifteen minutes.
The Patient	No special preparation is required. The investigation takes approximately 30 minutes. Imaging is performed while the patient is in a sitting position.
Radiation Dose to Patient	0.1 mSv from an administered dose of 8 MBq.
Comments	
References	BNMS Guidelines Lacrimal Scintigraphy. Report 2013. A. Madonald and S.Burrell. (2008) “Infrequently performed studies in Nuclear Medicine: Part I” JNMT 36(3): 132-143. J. Thrall and H.Ziesman. Nuclear Medicine: The Requisites 1995 Mosey, Missouri.