Introduction

The Ionising Radiation (Medical Exposure) Regulations [IR(ME)R] 2017 make it necessary for all investigations using ionising radiation to be justified on an individual patient basis. To meet this requirement, the Nuclear Medicine Department have produced the following table of referral criteria which, if met, would justify a Nuclear Medicine procedure under most circumstances. These are taken from professional body guidelines including:

- British Nuclear Medicine Society - www.bnms.org.uk
- European Association of Nuclear Medicine – www.eanm.org
- Society of Nuclear Medicine – www.snm.org

Referring Patients

Referrals are accepted from any hospital doctor who is, or acting on behalf of, a Consultant or an approved Non-Medical Referrer (NMR). The name of the referrer and Consultant must be clearly stated on the request, even if these are the same person. Referrals will be accepted as per points 4.1-4.6 in Trust IRMER Procedure 2 and those identified within Appendix 1 Table 1. Referrals are not commonly accepted from GP practices for specialist Nuclear Medicine studies. Please contact the department for more information about this.

Clinical Information

Under IRMER it is essential that requests for Nuclear Medicine procedures provide sufficient medical data for the practitioner to be able to justify and authorise the exposure. The regulations clearly state the responsibility of the Referrer: “The Referrer must supply sufficient medical data (such as previous diagnostic information or medical records) for the practitioner to be able to decide whether there is sufficient net benefit”. Please note that the Referrer remains responsible for the referral even if the task is delegated to another hospital doctor acting on their behalf. The practitioner for Nuclear Medicine will always be a clinician holding an IRMER Practitioner Licence Holder issued by ARSAC.

Patient Information Request

The following information about the patient is required as a minimum:

- Patient’s Surname
- Patient’s Forename
- Date of Birth
- Address
- Hospital ID
- Examination Requested
- Sufficient clinical information to justify the medical exposure requested
- Information related to pregnancy and breastfeeding (where relevant)
- In the case of pregnancy, the Referrer should confirm that a risk benefit discussion has taken place with the patient

- Indication of known potential medical complications associated with the requested examination e.g. allergy, renal function (for CT contrast)
- Signature of Referrer (this can be practical or an electronically validated request)
- Name of Referrer
- Date of Referral
- Name of Consultant
- Hospital/Ward/Department
- Research projects should be clearly identified

Please be patient if Nuclear Medicine staff contact you to ask for more information. Any referral not providing appropriate information as above will not be progressed and the Referrer will be contacted accordingly.

Radiation Protection of Other People

Nuclear Medicine investigations are different from other radiological investigations because the patients themselves become radioactive and may therefore pose a radiation risk to others. Please pay particular attention to any instruction sent back with the patient, with particular regard to whether urine and blood samples can be taken, bearing in mind these may both be radioactive. Occasionally investigations cannot be carried out because of the patient's family circumstances.

Radiation Dose to the Patient, Pregnancy and Breastfeeding

The list of investigations following contains information about the radiation dose received (in mSv) by the patient and this must be borne in mind when considering the suitability of using a Nuclear Medicine procedure. As a guide, the natural background radiation received by any person is about 2.3 mSv per annum. In a pregnant patient, there is also a radiation dose to the foetus; this must be strictly limited and the Referrer should have a risk benefit discussion with the patient prior to making the referral. Furthermore, many radiopharmaceuticals appear in breast milk, so a breast-fed infant would receive a radiation dose. For these reasons, the fact or possibility of pregnancy or breastfeeding must be clearly stated in the request for all individuals of childbearing potential in the age range 11-55 years old, inclusive.

Supplementary Drugs

Some investigations require the administration of other, non-radioactive pharmaceuticals as an essential part of the test. Your referral request will be taken as implying agreement to the administration of the specified supplementary drug (this includes the administration of saline). If you are unhappy about your patient being given these drugs or feel they are contraindicated, this must be clearly stated in the request. Please contact the department if you require any information about the use of supplementary drugs.

SPECT/CT

To aid in attenuation correction of Nuclear Medicine data, anatomical localisation and/or characterisation of lesions, many Nuclear Medicine studies now employ a

hybrid imaging approach, namely the use of SPECT/CT imaging. The dose burden associated with the CT imaging varies depending on the application, being lowest for attenuation correction and highest when diagnostic quality CT data is acquired. The dose information below includes the CT element for those studies where SPECT/CT is specified or may be employed, given in brackets below the radiopharmaceutical dose.

Less Common Procedures

Legal requirements mean that certain investigations are carried out in specified locations (namely either Queen Elizabeth Hospital, Good Hope Hospital or Brimingham Heartlands Hospital). If necessary, a request might be sent to another site. There may be other procedures which fall into the category of research investigations and the Practitioner should be contacted.

Cancelling a Request

If a request is made and then cancelled by the Referrer the Nuclear Medicine department **MUST** be contacted (see details below) to cancel the request.

Nuclear Medicine Department
Queen Elizabeth Hospital Birmingham
0121 371 2282

Reports

Patients referred will have images on PACS and reports available on PACS, CRIS, PICS and Clinical Portal once they are finalised. External reports and images will be sent via Image Exchange Portal (IEP).

Diagnostic Nuclear Medicine Referral Criteria

Note the table below is not an exhaustive list of referral criteria. Please contact the department if you have a query regarding a clinical indication which is not specified.

Effective dose estimates are based upon published data via relevant ICRP reports and ARSAC guidance. CT doses are based on typical estimates for the likely scanned area using the IMPACT dose calculator. Risk classifications are based upon classifications outlined in HPA-CRCE-028. For more information about this, please contact the department.

Investigation and Clinical History	Radiopharmaceutical	Effective Dose (mSv)	Risk Classification
Bone *Oncology* • Staging and restaging of osteoblastic bone metastases; mainly in the setting of prostate and breast cancer.	^{99m}Tc Oxidronate HDP	2.9 (CT: 6.4)	Low

• Aids in detection of primary and secondary bone tumours. *Bone disease* • Aids in the assessment of bone diseases including fractures (including stress fractures); metabolic bone disease; osteoarthritis, bone graft viability, mandibular growth, Paget's disease and shin splits. • Prosthetic joint or bone metalwork evaluation. *Infection* • Assessment of prosthetic joint or bone metalwork infection. • Identification of bone or joint infection. *Other* • Investigation of unexplained bony pain if structural imaging inconclusive.			
Bone Marrow • Assessment of extramedullary haematopoiesis. • Bone marrow imaging after an equivocal radiolabelled white cell scan (only if recommended by the reporting Nuclear Medicine radiologist). • Detection of splenuculus.	^{99m}Tc Nanocolloid	3.6	Low
Brain (DaTSCAN) Detects loss of dopaminergic neuron terminals in the striatum: • To help differentiate Essential Tremor from Parkinsonian Syndromes (DaTSCAN is unable to discriminate between Parkinson's Disease, Multiple System Atrophy and Progressive Supranuclear Palsy) • To help differentiate probable dementia with Lewy bodies from	^{123}I DaTSCAN	4.4	Low

Alzheimer's disease. (DaTSCAN is unable to discriminate between dementia with Lewy bodies and Parkinson's disease dementia).			
Gastric Emptying (Solid) +/- Small Bowel Transit • Assesses gastric emptying rate, identifying delayed (gastroparesis) and rapid (dumping syndrome) emptying. • Evaluation of small bowel transit can be performed when clinically indicated *(This must be clearly specified at the time of referral, as it is not performed routinely with gastric emptying studies)*.	^{99m}Tc DTPA	<0.1 (CT : 0.7 for small bowel transit)	Minimal
Gastrointestinal (GI) Bleed • Detection and localisation of selected cases of slow GI bleed if all other standard tests fail.	^{99m}Tc Pertechnetate	5.2 (CT: 2.4)	Low
Ileal Absorption (SeHCAT) • Investigation of bile salt malabsorption. • Investigation of chronic diarrhoea.	^{75}Se SeHCAT	0.3	Very Low
I-123 Post Ablation Quantification • Assessment of possible metastases post thyroid ablation.	^{123}I Sodium Iodide	60 (CT: 5.5)	Moderate
Kidney Renogram • Assessment of renal and collecting system drainage pattern and provides split renal function assessment. • Assessment of urine leak post-surgery if required.	^{99m}Tc MAG3 (or ^{99m}Tc DTPA)	0.7	Very Low
Kidney DMSA • Renal cortical assessment to detect any parenchymal defects and provides reliable split renal function assessment.	^{99m}Tc DMSA	0.7	Very Low
Kidney GFR • Measurement of renal function GFR (including	^{99m}Tc DTPA	0.05	Minimal

prior to chemotherapy; assessment and monitoring of chronic kidney disease or for potential live donors).			
Liver • Detection and visualisation of changes to normal hepatobiliary function (main indication is to assess gallbladder dyskinesia). • Assessment of bile leak..	^{99m}Tc trimethyl-bromo-IDA (T-BIDA)	1.3	Very Low
Liver Transplant or FLR • Future liver remnant (FLR) assessment prior to surgery. • Auxiliary liver transplant assessment.	^{99m}Tc trimethyl-bromo-IDA (T-BIDA)	2 (CT: 2.7)	Low
Lung Perfusion +/- Ventilation • Investigation of suspected pulmonary embolism (PE)-acute or chronic. • The Nuclear Medicine radiologist will decide if a ventilation study (+/- chest CT) is required.	^{99m}Tc Macroaggregated Albumin (MAA)	1.1	Very Low
Lung Perfusion +Ventilation quantification • Pre-operative evaluation prior to lung resection to assess differential lung function (right vs left, and lobar contribution).	^{99m}Tc Macroaggregated Albumin (MAA)	0.6	Very Low
Lung Shunt • Detection and quantification of right-to-left shunts including intracardiac, pulmonary arteriovenous malformations, and hepatopulmonary syndrome.	^{99m}Tc Macroaggregated Albumin (MAA)	1.1	Very Low
Lung Shunt SIRT workup • Assessment of hepatic arterial perfusion and uptake and assessment of percentage of activity which is shunted to lungs to guide 90-Y Selective Internal Radiation Therapy (SIRT).	^{99m}Tc Macroaggregated Albumin (MAA)	5.7	Low
Lymphoscintigram	^{99m}Tc Nanocolloid	<0.1	Minimal

• Investigation of lymphatic drainage from upper or lower limbs in cases of suspected lymphoedema.			
Meckel's Diverticulum • Investigation of Meckel's diverticulum.	^{99m}Tc Pertechnetate	2.6 (CT: 4.5)	Low
MIBG (Oncology) • Localisation, staging and follow up of selected cases of phaeochromocytoma and paraganglioma. • Staging and follow up of selected cases of neuroblastoma. • Investigation prior to possible mIBG therapy (referral from Oncologist / Endocrinologist only). • Please note the service also offer Ga-68 DOTA PET for these studies. Please discuss with a relevant Consultant NM Physician/Radiologist.	^{123}I mIBG	5.2 (CT: 17)	Moderate
Octreotide (Neuroendocrine) • Localisation of neuroendocrine tumours and metastases. Please note the service also offer Ga-68 DOTA PET for these studies.	^{111}In Octreotide	10 (CT: 5.4)	Low
Oesophageal Motility • Investigation of oesophageal transit and reflux.	^{99m}Tc DTPA	0.1	Minimal
Parathyroid Subtraction – dual isotope (I123/MIBI) • Localisation of parathyroid adenoma or hyperplasia, prior to surgery or in patients with persistent or recurrent disease (Conducted for patients taking thyroxine or levothyroxine or amiodarone) - at UHB this study is ideally performed after USS and CT neck.	^{99m}Tc MIBI	5.4/6.1 (CT: 2.1)	Low
Parathyroid Washout – Dual Phase (MIBI) • Localisation of parathyroid adenoma or hyperplasia,	^{99m}Tc MIBI and ^{123}I Sodium Iodide	5.4 ^{99m}Tc/^{123}I (CT: 2.1)	Low

prior to surgery or in patients with persistent or recurrent disease (conducted for patients taking thyroxine or levothyroxine or amiodarone) - at UHB this study is ideally performed after USS and CT neck.			
Sentinel Lymph Node Breast (SLNB) • Sentinel node localisation in breast cancer.	^{99m}Tc Nanocolloid	1 day : 0.1 2 day: 0.1	Minimal
Sentinel Lymph Node Melanoma (SLNM) • Sentinel node localisation in melanoma.	^{99m}Tc Nanocolloid	1 day : 0.2 2 day: 0.4 (CT: 1)	Very Low
Sentinel Lymph Node Penile (SLNP) • Sentinel node localisation in penile cancer.	^{99m}Tc Nanocolloid	1 day : 0.2 2 day: 0.4 (CT: 1)	Very Low
Thyroid – ^{99m}Tc • Evaluation of hyperthyroidism (thyrotoxicosis), particularly to determine if there is a toxic nodule. • May aid in the assessment of ectopic thyroid tissue if required.	^{99m}Tc Pertechnetate	1.0 (CT: 1.5)	Low
Thyroid – ^{123}I Can be used for the same indications stated for **Thyroid – ^{99m}Tc, however, at UHB, Thyroid – ^{99m}Tc is the first choice for these indications.** The main indications for **Thyroid – ^{123}I at UHB are** • Investigation of thyroid uptake, including prior to radio-iodine therapy. • Assessment of patients with elevated thyroglobulin levels with suspected recurrent thyroid cancer (whole-body imaging).	^{123}I Sodium Iodide	6.2 (CT: 0.7)	Low
Thyroid-MIBI • Aids in differentiation between type 1 and type 2	^{99m}Tc MIBI	3.3	Low

amiodarone induced thyrotoxicosis.			
Infection – White Cell/Leucocytes • Localisation and extent of infection particularly around prosthesis sites.	^{99m}Tc HMPAO	2.2 (CT: 5.2)	Low
Red Cell Mass (RCM) • Investigation of suspected polycythaemia (PRV). • Investigation for the differentiation of primary and secondary polycythaemia. • Investigation of anaemia. • Requests above from haematologists.	^{99m}Tc Pertechnetate labelled Red Blood Cells (RBC)	<0.01	Negligible
Heat Damaged Red Blood Cells (RBCs) • Determine whether mass is functional splenic tissue and/or assess localisation of splenic tissue. • Detect regenerating splenic tissue (splenunculus) following splenectomy. • Assessment of splenic function, including confirmation of functional asplenia or hyposplenism.	^{99m}Tc Pertechnetate	1.3 (CT: 1.4)	Low
Myocardial Perfusion Imaging (MPI) – • Assessment of ischemia. • Investigate equivocal Exercise Tolerance Test (ETT). • Ca score for new patients without any of the following: previous invasive CT coronary angiogram, previous bypass grafting, stents or PCI or those who have had a previous confirmed myocardial infarction.	^{99m}Tc Tetrofosmin (Myoview)	1 day: 6.4/2.3 Stress/Rest 2 day: 3.5/4.0 Stress/Rest (CT: 0.6) (Ca score CT: 0.7)	Low
MUGA • Evaluation of left and right ventricular ejection fraction. • Assessment of heart function prior to surgery, organ transplants,	^{99m}Tc Pertechnetate	9.6	Low

chemotherapy and other drug therapies.			
MIBG (Cardiac) • Aids in differentiation between idiopathic Parkinson's disease and other Parkinsonian syndromes. • Aids in differentiating between dementia with Lewy bodies and other dementias. • Evaluation of the risk of heart failure in patients with suspected poor innervation of myocardium.	^{123}I Metaiodobenzy-lguanidine (mIBG)	4.8	Low
DPD (Cardiac) • Investigation of cardiac amyloid in patients with known or suspected amyloidosis.	^{99m}Tc DPD	4.8 (CT: 0.8)	Low

() - Effective dose from CT