Scientific Support for Nuclear Medicine

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BNMS
BRITISH NUCLEAR MEDICINE SOCIETY

Science & Technology Facilities Council

Report prepared by:

Claire Greaves, Nottingham University Hospitals NHS Trust,
British Nuclear Medicine Society

Introduction

Nuclear Medicine is a thriving and evolving specialty where technological advances such as hybrid imaging and new diagnostic and therapeutic agents are leading to improved diagnostic and therapeutic outcomes. As technology becomes increasingly complex, strong scientific support for the service is essential to ensure quality, safety and regulatory compliance.

The purpose of this paper is:

- To highlight the knowledge and skills required to act as a physicist within a Nuclear Medicine service and act as a key duty holder under the relevant legislation
- To describe the functions provided by physicists within Nuclear Medicine
- To provide indicative numbers of staffing for small and large organisations and describe the risk associated with inadequate support

Scientific training within healthcare has evolved over the last 10 years, particularly following the implementation of the modernising scientific careers (MSC) programme. As a result Nuclear Medicine services will have staff who call themselves different things (Physicists, Clinical Scientists and more recently Healthcare Scientists), have taken different training routes, and had different routes to registration. For the purposes of this paper physicist is the preferred term as it most accurately reflects the background of the workforce, however clinical scientist is used when it is important to acknowledge the requirement of registration or status as consultant.

Another term that has come into use recently is 'Healthcare Scientist'. This is an umbrella term which covers a range of staff working in many scientific fields within the NHS ranging from assistant practitioners through to senior scientists. In Nuclear Medicine this includes Nuclear Medicine Practitioners (previously technologists) who would undertake the Practitioner Training Programme. Practitioners are not within the scope of this paper. However, it is important to recognise that there are real challenges for this workforce which do need to be considered.

Clinical Scientists in Nuclear Medicine

Clinical Scientist is a registered profession and a protected title only to be used by those on the Health and Care Professions Council (HCPC) register. Registered clinical scientists form the core of scientists currently working within Nuclear Medicine. Non registered scientists, within the NHS, may include those in training or those involved in research where any patient contact; initial practice; or research involving variation of practice or analysis; would involve input from the clinical team, either a registered clinical scientist, clinician, or another appropriate member of the department.

Training

Those entering Clinical Scientist training to be a Medical Physicist will normally have obtained an undergraduate degree in Physics, Engineering or a related subject; many enter with higher degrees.

Prior to the MSC programme there was a 4 year training scheme post degree. The first stage (part 1) included a specific MSc in Medical Physics and broad training across the Medical Physics specialties. In the second stage (part 2) trainees specialised in a subject area such as Nuclear Medicine. After this four year period of training in the Nuclear Medicine specialty, a scientist could apply

to HCPC and, if assessed as competent, obtain registration as a Clinical Scientist. At the point of registration Clinical Scientists have a basic skill set which makes them safe to work within Nuclear Medicine.

Clinical scientists now undertake a 3 year 'Scientist Training Programme' (STP) and are then eligible for HCPC registration as a Clinical Scientist. This scheme is run by the National School for Healthcare Scientists in England and Wales, with a centralised appointment process to the scheme. Northern Ireland run the same scheme but individual Health and Social Care Trust appoint staff. Scotland runs its own 3 year training scheme which is administered in Scotland by the Health and Care boards, but is similar in content to the STP. Completion of any of these routes, which have competitive entry, as well as an equivalence route leads to registration.

The STP scheme also has two parts. The initial training period addresses some of the breadth of Medical Physics and the trainees then specialise for the remainder of programme. The trainees also study for an MSc during the training period which reinforces the theoretical knowledge that they require. The STP programme also includes additional training in scientific and clinical methods.

Nuclear Medicine is not taught as a stand-alone specialty in this programme. Clinical Scientist coming into Nuclear Medicine, through this new route will however, have specialised training in Imaging with Ionising Radiation. This provides them with a broader knowledge as it includes Diagnostic Radiology which is a benefit to Nuclear Medicine services as many will now have SPECT/CT or PET/CT systems.

Career Structure of a Registered Clinical Scientist/ Physicist in Nuclear Medicine

Once qualified and accepted onto the HCPC register a physicist in Nuclear Medicine may advance their career, taking on more responsibility as their skills and knowledge increase and they are promoted. Once registered, the Clinical Scientist must keep up with their Continued Professional Development (CPD) to maintain their registration below briefly describes key levels within the profession.

Newly Qualified

A physicist at this level will be able to apply a broad range of scientific skills to support the routine day-to-day operation of Nuclear Medicine and perform a wide range of routine and non-routine tasks, advising and liaising with other staff as appropriate. However, they will require the supervision and advice of a more senior physicist in situations where: the tasks are novel, there are risks associated with the decision, or there are significant barriers to progress. Due to the complexity of the field, further experience is required in order to undertake key responsibilities.

Senior Physicist

A senior physicist, will have gained advanced theoretical and practical knowledge of Nuclear Medicine and be able to provide expert advice to the Trust. A physicist at this level would be expected to act independently and to be responsible for the day to day operations within a department performing a range of diagnostic procedures and routine therapies such as those with Iodine-131. They may also take a lead role within the department for one or more particular areas such as quality management, training or equipment QC. A senior physicist may require higher level support on specific tasks like

procurement, commissioning of equipment, legislatory inspections, decisions with significant consequences and novel or complex therapies. They would generally work as a Medical Physics Expert, a term defined under IRMER (Ionising Radiation Medical Exposure Regulations 2000).

Consultant Clinical Scientist / Consultant Physicist

These are the most senior and experienced physicists in nuclear medicine. Currently these are appoint ended by individual hospital departments. The new STP scheme in England and Wales allows registered Clinical Scientists to undertake a further 5 year Higher Specialist Scientist Training (HSST) programme. Those completing the scheme, which includes a professional doctorate and management training, should have the skills to become a Consultant Scientist, and would be eligible to be on a register of Consultant scientists. It is envisaged that other registered scientists could show equivalence to HSST and sit on the register. This scheme currently only operates in England and Wales, and completion of the training is not compulsory for entry to Consultant level.

A consultant physicist in Nuclear Medicine would have expert knowledge and wide ranging experience of Nuclear Medicine and possibly other Medical Physics specialties. A physicist at this level would be able to have a formal role in providing the Trust with advice and assurance on issues relating to legislation impacting on Nuclear Medicine. A consultant physicist would also be able to provide expert advice on a broad range of issues: provision of nuclear medicine services; procurement and commissioning of equipment; novel or complex therapies; radioactive waste management. A consultant physicist would usually have a leadership role within Nuclear Medicine, working with clinical colleagues to deliver the service.

Knowledge and Skills

Indicative knowledge and skills dimensions for Nuclear Medicine physicists are shown in the following table. The levels required increase as physicists progress within the profession. A registered Clinical Scientist would normally be appointed into a band 7 post, a senior physicist into a band 8a/8b and a Consultant Physicist into an 8c/8d depending upon the size of the hospital, the complexity of the workload and additional responsibilities.

Generic and Scientist Specific KSF levels

	Generic Band 7	Generic Band 8	NM Band 7	NM Band 8A	NM Band 8D
C1 Communication	**3**	**4**	**3**	**3**	4
C2 Personal and People Development	**3**	**4**	**3**	**3**	4
C3 Health Safety and Security	**3**	**3**	**3**	**3**	4

C4 Service Improvement	**3**	**4**	**2**	**3**	3
C5 Quality	**3**	**4**	**3**	**3**	4
C6 Equality & Diversity	**3**	**3**	**2**	**2**	2

Key Roles within Medical Physics

Standards and Regulations

Due to the complexities of working with unsealed radioactive materials, there is a large amount of legislation relating to Nuclear Medicine covering aspects such as transport, receipt, storage, patient use, handling of radioactive materials, radiation protection of patients and the public and radioactive waste disposal. On top of the routine legislation governing all aspects of healthcare, more than 20 additional pieces of legislation directly impact on Nuclear Medicine along with a similar number of guidelines from government agencies and professional bodies. Although support in interpretation is available from Radiation Protection services, the Nuclear Medicine physicist must have the ability to understand the regulations and design practical working practices which support high quality diagnostic and therapeutic Nuclear Medicine services that comply with these complex and often conflicting pieces of legislation, which are enforced by different agencies.

The need for specific scientists with expertise in Nuclear Medicine is now clearly defined within the legislation and within professional guidelines.

Key roles are defined within legal frame-work: The Medical Physics Expert (MPE), Radiation Protection Advisor (RPA), and Radiation Waste Advisor (RWA). The RPA has completed a portfolio of evidence and has obtained certification (RPA 2000). The RPA is normally a senior or consultant scientist. The RWA has a similar accreditation process. The MPE is currently an appointment made by an employer, and the grade will be decided locally, although MPEs tend to be reasonably senior staff.

The role of the MPE in Nuclear Medicine will be formally recognised within the next few years as the UK has until February 2018 to put into law the requirements of the 2013/59 EURATOM *The European Basic Safety Standard Directive (BSSD)* that places legal duties on the UK to formally recognise MPEs. A Medical Physics Expert Project established by the Department of Health and Health Education England (HEE) has developed curricula for education and training requirements for MPEs and advised on a framework for recognition of individual MPEs. Nuclear Medicine is one of three areas where the MPE will be formally recognised, the other two being Diagnostic and Intervential Radiology and Radiotherapy Physics. The MPE programme for newly registered clinical scientists is likely to commence within the next few years and is designed as a two year work place structured CPD programme. Staff already fulfilling the role of MPE will need to be formally recognised when this is established in UK law through some process yet to be established. It is thought that all clinical scientists working in nuclear medicine will be expected to be trained and formally recognised as MPEs.

Current advice on the requirements for MPE involvement in Nuclear Medicine are as follows:

Medical and Dental Guidance Notes [1]

The MDGN define an MPE as a state registered clinical scientist with corporate membership of IPEM (MIPEM) or equivalent and 6 years of appropriate experiences in the clinical specialism. The MDGN comment that there is a legal requirement for an MPE to be available and contactable in Nuclear Medicine practices and clearly involved in certain circumstances. They are responsible for ensuring the overall scientific and technical quality of the investigations and providing advice on a range of issues such as: QA; patient dosimetry – particularly for pregnant and breast-feeding women; analysis, display and presentation of results; specification and commissioning of new equipment; optimisation of techniques; ARSAC applications;, dose constraints for research exposures; assessment and validation of dedicated NM software; design of facilities; and all aspects of radiation protection - in collaboration with the RPA. In particular an MPE must have direct involvement with NM therapy.

ARSAC – requirements for an MPE [2]

The Ionising Radiation (Medical Exposure) Regulations 2000, regulation 9 requires that a medical physics expert is available. The degree of availability will vary with the range and complexity of procedures undertaken. Where services include complex therapeutic and diagnostic procedures, it is expected that at least one such person will be available on a fulltime basis.

Key Roles within Medical Physics

A Clinical Scientist in Nuclear Medicine may undertake a variety of roles which depend upon the organisational structure within each Trust and the other healthcare professionals involved in a particular department.

The core duties of the physicist in Nuclear Medicine were described by Williams et al. [3] and an excerpt is provided below. This paper was written in 1999 and has not been revised. In the intervening period, Nuclear Medicine equipment has become more complex as new technologies have emerged and become commonplace (e.g. SPECT/CT and PET/CT) and new diagnostic and therapeutic procedures have been developed. The knowledge and skills of the physicst have developed to match this. The role of the technologist has also evolved and some tasks which were performed by scientists are now routinely performed by technologists. A working party has been set up to review the scientific support requirements for Nuclear Medicine and publish guidance but this guidance is not expected for some time.

Table 1. Duties of the physicist in nuclear medicine.

Duties	*Examples*
A. Core activities of the nuclear medicine physicist	
Equipment management and equipment quality control (QC)	Equipment procurement (specification, evaluation of tenders, acceptance testing) and responsibility for all aspects of equipment QC including fault diagnosis
Support for diagnostic procedures	Applies to both imaging and non-imaging work and includes provision of advice on the range and suitability of investigations, responsibility for the technical aspects of acquisition, data analysis and presentation of investigations, non-clinical reporting, scientific support for technical and/or radiographic staff, and liaison with other staff groups as appropriate
Support for radionuclide therapy	The responsibility for the provision of advice, dosimetry, activity calculations, administering therapeutic doses, radiation protection and liaison with other staff groups as appropriate
Service development and monitoring	The establishment, introduction and validation of new procedures and protocols and the review of existing procedures and protocols
Research support	The provision of scientific and technical support for the research infrastructure within the hospital. For the assessment of physics staffing requirements (Table 2), those aspects of research in which physics support is independently funded are not included (see 4.5)
Quality assurance (QA)	The continuous monitoring of service organization, imaging and non-imaging procedures, equipment and software performance, non-clinical reporting, data presentation and staff training
Computer systems administration, software development, maintenance and QA	This is specific to the activities of the nuclear medicine department and includes advice on the legal liabilities associated with in-house software [21, 22]. It excludes information technology (IT) support to other hospital departments
Radiation protection	Radiation protection adviser duties and other radiation protection duties related to the work of nuclear medicine and radiopharmacy, in line with legislative requirements. This includes the production of local rules, management and responsibility for radioactive waste and its disposal, and the stock control and transport of radioactive materials
Management of scientific service	The management of the scientific service and the delivery of scientific support. This may include the management of other nuclear medicine physicists
Audit	Multidisciplinary clinical audit and external audit (e.g. Health and Safety Executive, Environment Agency)
Administration	Correspondence and record-keeping
Support for ARSAC certification procedure	Assist with ARSAC applications, review facilities and procedures and provide advice
Continuing professional development	To comply with the IPEM programme, a minimum of 50 h per person of recorded study per year is required
Professional activities/committee work	Involvement in hospital committees (including radiation safety) and activities associated with relevant professional societies
Education and training	Education and training of other NHS staff groups (for example, medical, nursing, pharmacy staff), particularly in relation to statutory legislation. For the assessment of physics staffing requirements (Table 2), formal teaching and the structured training of Grade A physicists in accredited training centres are not included (see 4.5)
Staff meetings	Clinical meetings, hospital management briefings and departmental meetings
B. Non-core activities: other essential activities which may or may not be carried out by the nuclear medicine physicist	
Nuclear medicine service management and budgetary control	Staff management responsibilities (covering secretarial and possibly nursing staff as well as physicists and technicians/radiographers), budget management, risk management, Trust audit, etc.
Radiopharmacy duties	Duties of Radiopharmacy Production Manager, implementation of quality systems within the radiopharmacy, Medicines Control Agency audit, etc.
Equipment maintenance	All maintenance other than first-line
Information technology support	General IT support to other hospital departments and to administrative and clerical staff
Scientific support for dual-energy X-ray absorptiometry (DXA) scanning	Equipment procurement, calibration and data analysis

Additional time would be required to support teaching, training and research as well as other non-core duties such as Radiopharmacy, IT support, and Management

Some of the core duties are not described adequately within this table but were described by Cosgriff et al [4] and are listed here

1.1 Equipment management

1.1.2 Procurement (specification, evaluation, selection, negotiation, acceptance testing)

1.1.3 QC

1.2 Data acquisition and processing

1.2.2 Quantification of results

1.2.3 Standardisation

1.2.4 Software quality assurance

1.2.5 Establishing normal ranges

1.2.6 Processing complex studies

1.3 Methods for image acquisition

1.3.2 Advising radiologists

1.3.3 Modifications to suit particular clinical circumstances

1.3.4 Protocols

1.3.5 Software testing and development

1.3.6 Automation

1.3.7 Reporting with radiologists

1.3.8 Reporting non imaging

1.4 Research and Development

1.4.2 Clinical Trials involving NM

1.4.3 IRAS/ARSAC applications

1.4.4 Estimation of doses to critical organs

1.4.5 Presentations and papers

1.5 Teaching and training

1.5.2 FRCR/BSc, Other staff within the hospital e.g. porters, drivers

1.5.3 Technologists

1.6 Quality assurance

1.6.2 ISO system

1.6.3 Equipment

1.6.4 Audit

1.7 Radiation protection

1.7.2 EPR, IRR, IRMER, MARS, Transport, Medicines Act etc

1.7.3 Ensuring staff safety within NM, the broader hospital and external organisations e.g. care homes

1.7.4 Ensuring public safety – discharge advice, risk assessments, travelling through ports

1.7.5 Ensuring patient safety (optimisation, dosimetry, special categories e.g. pregnant patients)

1.7.6 Risk Assessments

1.7.7 Local rules

1.7.8 Evaluation of dosimetry results

1.8 Radiopharmacy

1.8.2 Radiation safety

1.8.3 QA

1.8.4 Audit

1.8.5 Advice

1.8.6 Procurement

Staffing Levels for Nuclear Medicine

Recommended staffing levels for physicists in Nuclear Medicine were documented in 1999 [3] and are shown in the following table. These assume core duties only.

Table 2. Recommended staffing levels: Core duties only (hours per week).

	Small DGH	*Medium-sized DGH*	*Large DGH*	*Small TH*	*Large TH*
	1 camera, 1500 investigations mixed	*2 cameras, 2400 investigations + in vitro + therapy*	*2 or more cameras, 5000 investigations + in vitro + therapy*	*2 or more cameras, 5000 investigations + in vitro + therapy*	*3 or more cameras, 7000–10,000 investigations + in vitro + therapy*
Equipment management	1.5	2.5	4	4.5	5.5
Diagnostic procedures support	4.5	7.75	14.5	17.5	22.5
Radionuclide therapy support	0	1.75	2.5	2.75	4
Service development	2.25	3.5	5.5	6.75	10
Research support	1.5	2.5	6.75	9	12.25
Quality assurance	1.5	2.25	3	3	4
Computer system administration	1.5	2.5	4	6	9
Radiation protection	1.5	2.5	4.5	5	5.5
Management of scientific services	2	3	4	5.5	7
Audit	1	1.75	2	2.5	4
Administration	1.5	2.5	3.5	4.5	7
ARSAC support	0.5	1	1.5	2	2.25
CPD	0.5	1	1.5	2	3
Professional activities	0.5	1	1.5	2	3
Education and training	1.5	2	3	5	7
Staff meetings	0.5	1	1.5	2	3
Total hours[a]	22.25	38.5	63.25	80	109
Total sessions[a,b]	6	11	18	23	31

Note: This table excludes non-core duties described in Table 1B, funded research and formal teaching and training. Additional staff would be required for these duties. The same person does not necessarily perform all the duties in small and medium-sized district general hospitals.
[a] Additional hours will be required to cover for study and annual leave.
[b] Assuming 3.5 h per session and 10 sessions per week.
Abbreviations: DGH, district general hospital; TH, teaching hospital; CPD, continuing professional development.

So, for example, for a large teaching hospital, the recommended staffing levels are 2.9 physicists in addition to physicists to support radiopharmacy, management of the service and additional non-nuclear medicine roles. This does not include cover for leave.

BNMS survey data (2010) shows that for an acute hospital with 4 or more cameras serving a population of >700,000 the average number of physicists is 0.87 per camera. This equates to 4.5 physicists to support 5 cameras, reducing to 3.5 for 4 cameras and 2.6 for 3 cameras. The staffing would not decrease in a linear fashion. Small services still have to achieve legislative compliance, quality compliance, equipment management and support diagnostic and possibly therapeutic procedures and research.

In 1997, the European Federation of Medical Physics (EFOMP) also published minimum scientific staffing levels in a Medical Physics Department [5]. In this context, only staff who have had an approved course of training in radiation physics related to nuclear medicine should be included in the minimum staffing level of qualified medical physicist (the term Clinical Scientist is specific to the UK and the HCPC).

In 2014 Radiation Protection No 174 European Guidelines on Medical Physics Expert were published by a consortium led by EFOMP [6]. Annexe 2 of this publication describes the core duties of the MPE in Nuclear Medicine and provides a method of calculating both the specific WTE staffing requirements for the Nuclear Medicine Service but also the additional staffing across a Medical Physics Service (MPS) to support this.

Table 2 in this document from this document is reproduced here

Table 2: MPE Staffing Factors for Nuclear Medicine Equipment Dependent Factors	**Item**	**MPE WTE**	**MPS WTE**
Planar Gamma Camera	unit	0.02	0.05
Multi-head SPECT Gamma Camera - 99mTc only	unit	0.05	0.1
Multi-head SPECT CT Gamma Camera – 99mTc only	unit	0.05	0.1
Multi-head SPECT CT Gamma Camera - range of radionuclides	unit	0.1	0.2
PET/CT Camera – new installation	unit	0.3	0.5
PET/CT Camera – established installation	unit	0.1	0.2
Image Processing and Review on first Workstation	unit	0.05	0.1
Image Processing and Review on subsequent Workstations	unit	0.01	0.03
IT support for simple networked systems and workstations	unit	0.02	0.05
IT support for complex networked systems and workstations	unit	0.05	0.1
Automatic Gamma Counter	unit	0.01	0.05
Radionuclide Calibrator	unit	0.01	0.03
Patient Dependent Factors	**No. of procedures**	**MPE WTE**	**MPS WTE**
Planar imaging procedures not involving data processing	3 types	0.005	0.01
Imaging procedures involving data processing (e.g. renogram) with quantification or tomographic reconstruction (SPECT or SPECT/CT)	100	0.01	0.02
FDG oncology PET/CT imaging procedures	100	0.02	0.05
Any other PET/CT imaging procedures, without post-processing/quantification	100	0.02	0.05
Outpatient radionuclide therapy (e.g. 131-Iodide for ca. thyrotoxicosis)	50	0.01	0.03
Simple inpatient radionuclide therapy (e.g. 131-Iodide for ca. thyroid)	10	0.005	0.01
Complex radionuclide therapy (e.g. 131-mIBG, 177Lu, 90Y agents, monoclonal antibodies, novel bone pain palliation agents, labelled microspheres)	10	0.07	0.1
Non-imaging, laboratory procedures	100	0.01	0.03
Service Dependent Factors (3 Gamma Camera Department)	**Notes**	**MPE WTE**	**MPS WTE**

Ongoing service development	Per department	0.2	0.3
Clinical Governance including ongoing audits	Per department	0.2	0.3
Practical radiation protection support	Per department	0.1	0.3
Management of scientific service	Per department	0.1	0.1
Research and Training Dependent Factors	**Notes**	**MPE WTE**	**MPS WTE**
Research and Development including clinical research	Per department	0.2	0.3
Delivering training – internal	Per trainee	0.2	0.3
Education and training within service	Per department	0.04	0.05
Clinical Trials with trial specific QA requirements	Per department	0.04	0.05

Notes
a. Adequate provision must be made to cover for absences.
b. The installation of cyclotrons was considered to be outside the scope of this work and will need to be considered separately.
c. The WTE factors associated with the manufacture of radiopharmaceuticals was considered to be outside the scope of this work and will need to be identified separately.
d. For clarity, the MPS WTE includes the MPE WTE.

So for a Nuclear Medicine Department with 3 SPECT cameras with associated image processing systems and non-imaging equipment performing 5000 studies per year and 200 OP radionuclide therapies would require 2.0 MPEs but 3.6 physics staff in total. If the staff work at multiple locations, an additional WTE component will need to be factored in to allow for travelling time.

In 2013, the French Nuclear Safety Authority and the French Society of Medical Physics published a document detailing the personnel required for Medical Imaging Requirements [7]. This describes a method of calculating the FTE medical physics requirements per machine taking into account: the equipment complexity (Factor A), the clinical complexity factor (B), the Patient Activity (Factor C), and the equipment diversity (Factor D),

FTE Physics/machine = FTE equipment x A x D + FTE clinical x B x (number of patients/C).

Recommended levels are given for different scenarios. For example

A department with one SPECT camera (4 sets of collimators, 2500 patients per year), 1 PET-CT scanner (2500 patients per year) and 2 dose calibrators would require 0.46 WTE physicists per year

A larger department with Department equipped with 1 SPECT camera (2500 patients per year), 1 SPECT/CT scanner (2500 patients per year), 1 PET/CT scanner (2500 patients per year), 2 dose calibrators, a therapeutic activity (60 patients per year in non-cancer therapy and 60 patients per year in systemic cancer therapy) would require 0.690 extrapolated to 1 WTE because of the therapy procedures

In the UK it is not yet commonplace to have PET/CT and SPECT/CT in the same department and so the above calculations for small departments with a single PET/CT or SPECT/CT work out at around 0.3 WTE.

UK recommendations for scientific support for PET/CT services were published in 2005 by the Royal College of Radiologists [8] which proposed that *"At least one dedicated medical physicist is required for the operation, support and development of a basic, routine scanning service on a fixed site. This person may well be distinct from the MPE. Duties will include setting up equipment, defining system protocols, administering radiation protection, monitoring regulatory issues, image handling, exercising quality control, and general troubleshooting. Hubs performing non-standard or clinical research activities will require additional input from trained and experienced medical physicists."*

This level of support was confirmed by the Institute for Physics and Engineering in Medicine in their document Recommendations for Clinical Scientist Support for PET-CT in 2008 [9
It is difficult to specify minimum staffing levels but BNMS would advise that small services should have a minimum of 0.6 WTE physicist support dedicated to Nuclear Medicine Physics. Where there are single handed NM physicists we would strongly advise that they are part of a formal Medical Physics Service or have buddying arrangements with larger Trusts and undertake regular organisational audit.

In some organisations medical physicists have a much greater involvement in the management, leadership and development of Nuclear Medicine services; they may also have a consultative role in advising medical colleagues of the studies and techniques available and may assist in the presentation and interpretation of results. These aspects of the work are not covered in this document. For example, in one service the clinical scientists authorise requests and provide advice on the protocol to be followed, as well as traditional physics support and image processing. Senior physicists may also have a role in managing the service. This is not uncommon and physics staff are frequently involved in reporting studies, the management of radiopharmacy, managing quality systems, managing Nuclear Medicine IT and procurement.

The financial pressures on the NHS have placed tremendous pressure on Trusts. Scientific support is a relatively expensive resource and the value of it is often poorly understood. However, the training and expertise of Clinical Scientists mirrors that of Consultant specialists in Medicine and it takes approximately 10 years to develop a Consultant Clinical Scientist. It is important for Trusts to be aware that Nuclear Medicine is a complex speciality where expert advice is required to ensure the levels of quality required to ensure accurate diagnostic and therapeutic outcomes. The range of legislation governing the production, use and

disposal of radioactive materials is huge and results in an arduous inspection regime from multiple agencies such as: the Office for Nuclear Regulation (for transport); the Medicines and Healthcare products Regulatory Agency; the Health & Safety Executive; the Environment Agency and Counter Terrorism Security Advisors. In order to provide a high quality service and to protect patients, staff and the public; good quality scientific support with experienced leadership at an appropriate level is paramount. The risks associated with lack of scientific support are detailed in appendix 1

The demographics of the scientific workforce are also of some concern. HEE predict a 10-15% shortfall of senior scientists in the next 2-5 years. Also the health technology industry is growing and their demographics are worse and so they will be competing for the same staff. Trusts need to develop workforce strategies that ensure adequate training, recruitment and retention of physicists in NM and they need to do this now.

Conclusion

Scientific Support for Nuclear Medicine Services is critical for high quality diagnostics and therapies and to ensure new technologies are implemented into the health service rapidly and safely. There are significant risks associated with poor scientific support for Nuclear Medicine. This paper provides details of the training and experience of physicists in Nuclear Medicine, the complex range of functions that these scientists provide and the numbers required within organisations.

Appendix 1. Risk assessment- lack of scientific support for nuclear medicine

GENERAL RISK ASSESSMENT FORM | **Ref. No.**

Directorate: ***Site:***
Dept/Ward: Nuclear Medicine **Review Date:**

Task/Activity: Scientific support for the Nuclear Medicine service

Summary of Risks/Hazards/Impact, including people at risk:

i. Patient Safety –

   a. Risk from ionising radiation (to patients and general public), mis-diagnosis due to poor performance of equipment

   b. Risk to patients and staff from lack of time to perform appropriate radiation risk assessments prior to therapy

ii. Risk of cancellation/delays to therapeutic treatments due to low staffing levels

iii. Risk of poor quality image data or analysis due to lack of expertise

iv. Breaching regulations – Inadequate staffing to put safe systems of work in place and to police these

v. Data handling – loss of patient data resulting in repeat exposures and delays in treatment due to inadequate support

vi. Quality of service – inadequate review and maintenance of procedures and protocols

vii. Continuity of service – further loss of current staff would mean the service may not be able to operate or be severely restricted

viii. Development of service

   a. inability to respond to requests for new services or changes to the existing service in a timely fashion
   b. inability to keep abreast of developments in the field and lack of time to up-date and develop the service and implement new techniques

Existing Controls: Prioritisation of work based on relative risks

Current Risk Rating (use matrix overleaf)			
Risk:	**Likelihood x**	**Impact =**	**Risk rating**
Patient Safety	**3**	**3**	**9 (mod)**
Risk of cancellation/delays to therapy	**5**	**2**	**10 (mod)**
Risk of poor quality data	**3**	**3**	**9 (mod)**
Breach of regulations	**4**	**4**	**16 (high)**
Data handling	**2**	**3**	**6 (low)**
Quality of service	**3**	**3**	**9 (mod)**
Continuity of service	**4**	**4**	**16 (high)**
Development of service	**5**	**2**	**10 (mod)**

Recommendations for action:	Target Date:	Completion Date:
Increase levels of scientific support	**ASAP**	
Manager responsible for action:	**Designation**: **Signature:……..**	
Review date:……	**Cost……..**	

Risk rating if actions completed (use matrix below)			
Risk:	**Likelihood x**	**Impact =**	**Risk Rating**
Patient safety	**1**	**3**	**3 (low)**
Risk of cancellation/delays to therapy	**1**	**2**	**2 (low)**
Risk of poor quality data	**1**	**3**	**3 (low)**
Breach of regulations	**1**	**4**	**4 (low)**
Data Handling	**1**	**3**	**3 (low)**
Quality of service	**1**	**3**	**3 (low)**
Continuity of service	**2**	**3**	**6 (low)**
Development of service	**3**	**2**	**6 (low)**

RISK MATRIX	**IMPACT**				
Likelihood	**INSIGNIFICANT 1**	**MINOR 2**	**MODERATE 3**	**MAJOR 4**	**EXTREME 5**
Rare 1	**Low (1)**	**Low (2)**	**Low (3)**	**Low (4)**	**Low (5)**
Unlikely 2	**Low (2)**	**Low (4)**	**Low (6)**	**Moderate (8)**	**Moderate (10)**
Possible 3	**Low (3)**	**Low (6)**	**Moderate (9)**	**Moderate (12)**	**High (15)**
Likely 4	**Low (4)**	**Moderate (8)**	**Moderate (12)**	**High (16)**	**High (20)**
Almost Certain 5	**Low (5)**	**Moderate (10)**	**High (15)**	**High (20)**	**Extreme (25)**

RISK RATING **ACTION REQUIRED**

Low (1 – 6) Acceptable risk requiring no immediate action. Review annually.
Moderate (8 – 12) Action planned within one month; commenced within 3 months. Review in 3 months. Place on Risk Register.
High (15 – 20) Immediate action. Review at monthly intervals. Place on Risk Register.
Extreme (25) Immediate action. Details to Director of Corporate & Legal Affairs. Review weekly.

Risk Assessors Name*:* Designation:	Signature: ……. Date:
Assessment & action plan accepted by line manager:	YES
Managers Name:	Signature:…….. Date:……
Transferred to Risk Register:	YES ☐ NO ☐
Datix Input ID No:	Date:

1st Review:	Name of Reviewer: ……	Signed: ……	Date: ……
2nd Review:	Name of Reviewer: ……	Signed: ……	Date: ……
3rd Review:	Name of Reviewer: ……	Signed: ……	Date: ……

References

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