
Guidelines for the Provision of Physics Support to Nuclear Medicine

Report of a Joint Working Group of the British Institute of Radiology, British Nuclear Medicine Society and Institute of Physics and Engineering in Medicine

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1. Introduction

1.1 Definition. The World Health Organization has defined nuclear medicine as: 'that specialty which embraces all applications of radioactive materials in diagnosis or treatment or in medical research, with the exception of the use of sealed radiation sources in radiotherapy' [1].

1.2 Multidisciplinary nature. The success of nuclear medicine depends largely on its multidisciplinary nature, bringing together the skills of clinicians, physicists, pharmacists, technologists and nurses. The complementary roles of these various specialist groups has led to the successful introduction and routine use of a broad range of nuclear medicine procedures for both diagnosis and therapy. In addition, such an approach is an essential requirement for research applications using or developing nuclear medicine techniques.

1.3 Scope and trends. The scope of nuclear medicine is diverse. It includes *in vivo* and *in vitro* applications, imaging, non-imaging and radionuclide therapy. The unique ability to study physiological and pathological processes by non-invasive methods means that nuclear medicine procedures are also used extensively for research.

There is a definite trend towards increasing specialization and complexity within nuclear medicine, not only in equipment but also in procedures. There is also

evidence that the field of nuclear medicine is expanding, both in terms of workload and diversity [2].

For the nuclear medicine service to be safe, effective and responsive to clinical needs, it must be supported by appropriately qualified and skilled scientific staff.

2. Purpose of this report

2.1 This document gives professional guidance on levels of physics support required for the provision of a safe, effective and responsive nuclear medicine service.* It identifies the role of the physicist in nuclear medicine and provides a clear statement of duties. A standard for the delivery of a nuclear medicine service is given in the appendix.

2.2 The Institute of Physics and Engineering in Medicine (IPEM) (formerly IPSM) has previously published policy statements on (a) the role of the physical scientist in nuclear medicine [3], and (b) recommended minimum staffing levels for the medical physics support of nuclear medicine [4]. This document represents a revision of those policy statements and is endorsed by three of the major professional societies supporting nuclear medicine, IPEM, the British Nuclear Medicine Society (BNMS) and the British Institute of Radiology (BIR).

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* These guidelines apply irrespective of the method of providing the nuclear medicine service. This may, for example, be as a stand-alone department or as a section of an imaging or medical physics service.

2.3 In 1997, the Royal College of Physicians (RCP) published guidelines on the levels of consultant medical staff time required for the provision of a safe and effective nuclear medicine service [5]. This was published to assist informed discussion between consultant medical staff and managers and to provide guidance to management to assist them in making provision for medical cover. The present document is intended to assist nuclear medicine staff and management in the planning and provision of appropriate physics support to nuclear medicine. It follows the format of the RCP report.

3. The requirement for physics support to nuclear medicine

3.1 There is a statutory requirement for physics support to nuclear medicine. This follows from European directives and UK legislation, which state that employers have a duty to make available the services of an appropriately qualified expert in the application of physics to the diagnostic and therapeutic uses of ionizing radiation. Specifically, hospitals will require the service of physicists to ensure compliance with the following legislation (or forthcoming legislation arising from the European Directives):

- (i) The Medicines (Administration of Radioactive Substances) Regulations (1978) [6] (known as MARS)
- (ii) The Ionizing Radiations Regulations (1985) [7]
- (iii) The Ionizing Radiation (Protection of Persons undergoing Medical Examination or Treatment) Regulations (1988) [8] (known as POPUMET)
- (iv) Radioactive Substances Act (1993) [9]
- (v) The Ionizing Radiations (Outside Workers) Regulations (1993) [10]
- (vi) The Radioactive Material (Road Transport) (Great Britain) Regulations (1996) [11]
- (vii) Carriage of Dangerous Goods by Road (Driver Training) Regulations (1996) [12]
- (viii) Council Directive 96/29/EURATOM (1996) [13]
- (ix) Council Directive 97/43/EURATOM (1997) [14]

An example of the broad basis of the physics support which is required under the MARS regulations is outlined in paragraph 2.24 of the ARSAC (Administration of Radioactive Substances Advisory Committee) Notes for Guidance [15].

3.2 Qualified physicists within nuclear medicine departments* are employed as grade B or C clinical scientists. Staffing levels in medical physics have recently been the subject of a European Federation of Medical Physics (EFOMP) Policy Statement [16]. This identifies the need for all nuclear medicine departments to be supported by at least one qualified and experienced physicist. In this document, it is assumed that this refers to an 'independent practitioner'. The Registration Council for Clinical Scientists holds the view that only those physicists at grade B17 or above may be considered independent practitioners [17]. The appropriate grade for such an independent practitioner (grade B17–24 or C23–36) is based on the level of managerial or scientific responsibility, and the requirement for leadership of research and development. It would normally be expected that a large district general hospital or a teaching hospital would employ at least one whole-time equivalent nuclear medicine physicist at grade C. Additional grade C physicists may be appointed depending on the level of complex and/or innovative work individual posts demand. Smaller hospitals may appoint an independent practitioner at grade B or grade C as appropriate. Any physicists appointed below grade B17 must work under the supervision of an independent practitioner. The grading of all posts requires reference to the IPSM Policy Statement on Guidance on Assessment Criteria for Medical Physicists [18].

3.3 If the organization of the nuclear medicine physics service is such that supervision of all physicists by a single independent practitioner is not practical, then the employment of more than one physicist at an independent practitioner grade is necessary. An example would be when the physics department has a significant commitment to more than one site.

4. The role of the physicist in nuclear medicine

4.1 Nuclear medicine has flourished in the UK due to the cooperation of medical staff, physicists, radiopharmacists and technologists. To maintain the quality of service, in the light of the recent emphasis in the NHS towards multi-skilling, necessitates the

*Several models for physics support for nuclear medicine exist. For example, physicists may be employed directly by a department of nuclear medicine or, alternatively, by a department of medical physics. Often medical physics provide services for a variety of departments. For the purposes of this document, a nuclear medicine department and a nuclear medicine section of a medical physics department are taken to be equivalent.

clear definition of all staff group roles and the benefits they bring to the service. Integration into Europe and the inevitable differences in structures in other countries further support the need for unambiguous statements of duties.

- 4.2 Seven broad areas in nuclear medicine have been identified where physicists are considered to have a distinct role [19]. Within these areas, some tasks can be clearly assigned to physicists; these are in part associated with statutory requirements. Other tasks, although frequently performed by physicists, could be undertaken by other staff groups. For some of these tasks, there will be no clear demarcation between the professions and this flexibility benefits the service. In addition, tasks exist which are not related to an immediate service provision but whose removal would be detrimental to the service (e.g. funded research).
- 4.3 The increasing complexity of equipment and specialist patient investigations, together with tighter radiation protection and environmental controls [13], underline the need for physics input to provide a safe and effective nuclear medicine service. In addition, the formal requirements for training in physics aspects of nuclear medicine for ARSAC certificate holders emphasize the importance of the role played by appropriately qualified physics staff in the teaching and training of clinical and other staff groups.
- 4.4 The list of activities in Table 1 has been developed by the IPEM/BNMS/BIR joint working group to define the role of the physicist in nuclear medicine. In the breakdown of duties, the core duties are those in which the expertise of a physicist is essential. Others may be performed by the physicist in nuclear medicine or by staff from another discipline, depending on local circumstances. It is recognized that, in many centres, the physicists have a significant involvement in service management, including budgetary control. This is an acceptable physics role provided that the physicist as service manager has the organizational and administrative authority to deliver a safe service [5, 20]. Additionally, it must be recognized that an independent practitioner may have radiopharmacy duties and may also act as a Radiopharmacy Production Manager. The separation of duties into core and non-core tasks in Table 1 takes into account these differing situations.
- 4.5 Teaching, training and research are important aspects of the nuclear medicine physicist's role. In the case of activities such as university teaching and independently funded research, it is expected that the time and resources required will be in addition to those needed for the core duties.

5. Assessment of workload

- 5.1 In assessing workload, the working group used a system of identifying nominal time for the physicist duties listed in Table 1 as core activities, weighting these for different hospital models, as used by the RCP [5]. Information from personnel working in each type of department was obtained by widespread consultation within the three societies represented on the working group.
- 5.2 It was not considered appropriate to recommend staffing requirements for those duties defined as non-core activities. In departments in which the nuclear medicine physicist is required to perform such duties, additional staff resources should be allocated as appropriate.
- 5.3 It has been assumed that an adequate number of staff in allied professional groups is available. It is also assumed that technologists or radiographers perform all *routine* technical procedures (e.g. imaging, image processing and sample counting).
- 5.4 The contribution of grade A trainees to the provision of service has not been included. Their service commitment is very small and is more than balanced by the additional commitment to their training by staff employed at B and C grades.
- 5.5 In assessing workload requirements, the grading of physicists has not been specified. However, it is essential that the number of physicists employed as independent practitioners is appropriate to the level of managerial or scientific responsibility. Furthermore, all posts should be graded with reference to the IPSM Policy Statement on Guidance on Assessment Criteria for Medical Physicists [18].

6. Physicist staffing requirements for nuclear medicine

- 6.1 Table 2 gives the recommended requirements for physicist staffing levels, in terms of workload, for five types of hospital, ranging from a small district general hospital to a large teaching hospital. A varied case mix is presented, ranging from 1500 investigations per annum in a small district general hospital to 10,000 or more investigations per annum in large teaching hospitals. Clearly, not all hospitals will be comparable with the models chosen and, in these instances, appropriate adjustments to the recommended staffing levels will need to be made.
- 6.2 In all cases, the figures in Table 2 assume that physics support is provided by trained staff and that equivalent cover is provided during periods of study and annual leave.
- 6.3 No specific consideration has been given to local circumstances such as multi-sited organizations. These

Table 1. Duties of the physicist in nuclear medicine.

<i>Duties</i>	<i>Examples</i>
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

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

	<i>Small DGH</i>	<i>Medium-sized DGH</i>	<i>Large DGH</i>	<i>Small TH</i>	<i>Large TH</i>
	<i>1 camera, 1500 investigations mixed</i>	<i>2 cameras, 2400 investigations + in vitro + therapy</i>	<i>2 or more cameras, 5000 investigations + in vitro + therapy</i>	<i>2 or more cameras, 5000 investigations + in vitro + therapy</i>	<i>3 or more cameras, 7000–10,000 investigations + in vitro + therapy</i>
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.

would entail greater time commitment in travelling between sites and for cover for leave of other staff.

6.4 The additional physics support required in departments offering positron emission tomography (PET) has not been taken into consideration.

6.5 It should be noted that a substantial increase in time and resources is needed if a medical physics department is responsible for the overall management of the nuclear medicine service or parts thereof. This has not been taken into consideration in Table 2.

Appendix: Standards of delivery of a nuclear medicine service

The British Nuclear Medicine Society offers purchasers of nuclear medicine services the following policy statement on standards for the safe practice of nuclear medicine (* statutory requirement).

A Medical standards

1* The clinical nuclear medicine service shall be delivered under the responsibility of one or more clinicians

holding the relevant ARSAC certificates for that site.

2 The number of dedicated consultant sessions shall be appropriate for the workload.

3 Consultants responsible for the delivery of the clinical nuclear medicine service shall be trained to an appropriate standard, usually that defined by the specialist professional body.

4 Medical reports shall be the responsibility of one or more consultants with appropriate experience and training. A medical opinion can only be given by a medically qualified individual.

5 Adequate arrangements for consultant cover shall be in place at all times.

6 Adequate provision for study leave and/or continuing education for clinical staff shall be identified in *Terms and Conditions of Service*.

B Scientific and technical standards

1* Scientific and technical support shall be provided through dedicated medical physicists and technologists in accordance with the recommendations of

the IPEM, BNMS, HSG(95)3 [23] and relevant current legislation. Such staff shall be trained to an appropriate standard as defined by the appropriate professional bodies.

- 2* The service of a *radiation protection adviser* shall be available for the provision of advice on relevant current legislation and other radiation protection matters.
- 3* A *radiation protection supervisor* shall be appointed by the provider unit.
- 4 Adequate provision for study leave and/or continuing education for scientific and technical staff shall be identified in *Terms and Conditions of Service*.

C Organizational standards

- 1 The nuclear medicine service shall be managed by a suitable person with the organizational and administrative authority to deliver a safe service.
- 2* Radiopharmaceuticals shall be made available through qualified staff in an approved environment. Written procedures for the preparation, dispensing and administration of such agents shall be accessible and reviewed at regular intervals.
- 3 UK licensed products shall be used except when written authorization on an individual patient basis is provided by the clinician holding the relevant ARSAC certificate.
- 4* The provider site shall hold a certificate of registration for the keeping and use of radioactive materials and be appropriately authorized to accumulate and dispose of radioactive waste in accordance with relevant current legislation, unless exempt from so doing.
- 5* Procedures shall be in place to ensure that the transport of radioactive materials meets relevant current legislation.
- 6* Measures to monitor and control the radiation exposure of patients, staff and members of the public must satisfy the requirements of relevant current legislation.
- 7 The policies, procedures and delivery of the service shall be subject to organizational audit at agreed intervals.
- 8 All investigations or therapies shall be performed only on receipt of forms signed by a medical practitioner and these forms shall be made available by the provider unit.
- 9 Audit standards for the delivery of the service shall be agreed to include the range of services to be supplied, interval between request, appointment and report, and other quality measures.
- 10 An adequate staff mix for the safe delivery of the service and appropriate patient care shall be in

place. There shall be compliance as appropriate with the Patients' Charter and the Children's Charter.

- 11 Services shall be provided in an environment which is conducive to good patient care, with particular emphasis on cleanliness, timeliness, pleasant attitude and appearance of staff. Patient privacy, dignity and ethnic origin shall be respected.
- 12* All research procedures shall be performed in accordance with the terms of the Local Research Ethics Committee and the ARSAC certificate specific to that project.

D Equipment and facilities

- 1 The service shall be delivered through safe equipment that meets current accepted standards of performance.
- 2 Performance of equipment, in particular gamma cameras and dose calibrators, shall be assessed at suitable intervals. Records shall be maintained and be available on request.
- 3 Radiation monitoring, imaging, counting and data-processing facilities appropriate to the level of service shall be available.

Glossary

ARSAC	Administration of Radioactive Substances Advisory Committee of the DoH set up under the Medicines (Administration of Radioactive Substances) Regulations 1978 (SI 1978 No. 1006) and the Medicines (Radioactive Substances) Order 1978 (SI No. 1004).
BIR	British Institute of Radiology
BNMS	British Nuclear Medicine Society
CPD	Continuing professional development
DXA	Dual-energy X-ray absorptiometry
DGH	District general hospital
EFOMP	European Federation of Medical Physics
HSG	Health Service Guidelines
IPEM	Institute of Physics and Engineering in Medicine
IT	Information technology
MARS	Medicines (Administration of Radioactive Substances) Regulations 1978 (SI 1978 No. 1006)
RCP	Royal College of Physicians
TH	Teaching hospital
QA	Quality assurance
QC	Quality control

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