



ACPSEM

Australasian College of Physical Scientists & Engineers in Medicine

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Roles and Responsibilities
of
Nuclear Medicine Physicists

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Roles & Responsibilities of Nuclear Medicine Physicists

1. INTRODUCTION

This document provides details of the roles and responsibilities of Nuclear Medicine Physicists. Its style is intended to be non prescriptive, partly because nuclear medicine is a rapidly changing field.

The Nuclear Medicine Physicist is an essential member of the multi-professional team responsible for the design and delivery of nuclear medicine diagnosis and treatment. The roles and responsibilities of Nuclear Medicine Physicists are diverse and demanding for the safe and effective use of nuclear medicine procedures.

Nuclear Medicine Physicists apply their knowledge of mathematics, physics and technology to establish, implement and monitor processes which allow optimal diagnosis and treatment, taking account of the radiation protection of the patients and others. There has been considerable concern about the radiation dose received by patients from diagnostic imaging and over exposures during diagnostic imaging. This highlights the need for optimising the radiation dose to ensure the dose is kept low without compromising the diagnostic information obtained from the test. Nuclear medicine physicists play a key role in achieving this goal.

Nuclear Medicine Physicists are responsible for ensuring that the equipment, systems and processes used in nuclear medicine will produce the desired diagnosis when they are applied correctly by the nuclear medicine technologists. They must be able to recognize common artefacts in clinical images and undertake remedial action to correct the problem. Nuclear Medicine Physicists recognize and understand the sources of error in nuclear medicine studies and are responsible for the validation of the techniques used.

Nuclear Medicine Physicists are involved in both patient related activities and in the development, implementation, maintenance and quality control of the infrastructure (facilities, equipment & clinical computer systems) and processes necessary for the provision of nuclear medicine. They are scientifically trained in the techniques for accurate measurement and numerical recording that underlie a proper quality control system for the equipment used in nuclear medicine.

Nuclear Medicine Physicists have the ability to critically assess faults, and assign tolerances, test frequencies and remedial action. The decision to hand over a piece of nuclear medicine equipment for clinical use after a repair which might affect the clinical accuracy of the equipment must be made by a Nuclear Medicine Physicist in consultation with the service personnel carrying out the repair. This may require a balanced judgement between the need to provide a clinical service to patients and the need for diagnostic accuracy.

2. NUCLEAR MEDICINE PHYSICIST

The ACPSEM will register a medical physicist as being a qualified **Nuclear Medicine Physicist** if he/she has been awarded ACPSEM *Accreditation in Nuclear Medicine Physics*.

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ACPSEM accreditation certifies that the registered medical physicist has obtained sufficient knowledge and experience to be judged as *qualified* so that he/she may accept responsibility and practice independently in the specialty of nuclear medicine physics.

To be granted ACPSEM accreditation in nuclear medicine physics, a medical physicist must:

- have obtained a degree in physics, engineering, or an approved equivalent discipline from a tertiary institution, that is approved by the ACPSEM;
- have obtained an ACPSEM approved postgraduate degree in medical physics from a tertiary institution or an approved equivalent unless exempted by the ACPSEM;
- have at least three years postgraduate clinical experience in the application of medical physics in nuclear medicine;
- be eligible for ordinary membership of the ACPSEM and;
- satisfy the Accreditation Panel in Nuclear Medicine Physics that he or she has achieved the necessary level of knowledge and competencies to accept responsibility and practice independently in nuclear medicine physics.

The ACPSEM has a well established Training Education and Accreditation Program (TEAP) which provides a structured training approach for new entrants into the field of nuclear medicine physics to achieve the required competencies leading to accreditation.

3. AREAS OF RESPONSIBILITY IN NUCLEAR MEDICINE

Ten broad areas can be identified where Nuclear Medicine Physicists have a distinct role. They are:

- Radiation protection;
- Scientific integrity and accuracy of radionuclide counting and imaging systems (including optimisation and safety);
- Quality control, safety and maintenance of nuclear medicine equipment;
- Unsealed radionuclide therapy including the scientific integrity and accuracy of radiation dosimetry and the radionuclide administration processes (including optimisation and safety);
- Equipment procurement, acceptance and commissioning;
- Clinical computing and networking;
- Quality Management;
- Management, scientific responsibility, advice and direction;
- Teaching and training; and
- Research and development.

Some of these broad areas warrant further explanation and details are provided below:

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4. RADIATION PROTECTION

There are legal requirements on an employer to ensure the radiation safety of patients, members of the public and staff. This can be achieved by employing appropriately qualified and trained medical physics staff. The legal framework for these requirements is contained in Australian State and Territory ionising radiation regulations and codes of practice, including those published by ARPANSA and those formerly published by the NHMRC. These include RPS14 *Code of Practice for Radiation Protection in the Medical Applications of Ionizing Radiation* (1), and the associated RPS14.2 *Safety Guide for Radiation Protection in Nuclear Medicine* (2), RPS4 *Recommendations for the Discharge of Patients Undergoing Treatment with Radioactive Sources* (3) and RPS8 *Code of Practice for the Exposure of Humans to Ionizing Radiation for Research Purposes* (4). RPS14.2 recognises the nuclear medicine physicist as a Qualified Expert, as defined in RPS14. The legal requirements in New Zealand are contained in the New Zealand Radiation Protection Act, the Radiation Protection Regulations, and the National Radiation Laboratory (NRL) *Code of Safe Practice for the use of Unsealed Radioactive Materials in Medical Diagnosis, Therapy, and Research* (5).

The Nuclear Medicine Physicist will be responsible for radiation protection within the nuclear medicine facility and will often have responsibility for radiation safety within the whole organisation as the facility's Radiation Safety Officer.

The Nuclear Medicine Physicist is responsible for:

- Providing advice on the radiation safety of individual patients undergoing nuclear medicine. Particular emphasis is placed on minimising the dose to organs at risk, particularly the foetus and the gonads of patients of reproductive capacity;
- Providing advice to ensure that any exposure of the patient's relatives/friends is minimised;
- Maintaining records of radionuclides used and for monitoring their safety;
- Providing advice on the discharge of patients who have been treated with radionuclides and advice on the disposal of corpses containing radionuclides;
- The administration of appropriate authorizations/licences/registrations for the use of radionuclides within the nuclear medicine department and giving advice on these;
- Carrying out any measurements, investigations or assessments which are deemed necessary to verify radiation safety or in the event of a radiation incident;
- The management of the decontamination of persons or the workplace after a spill or contamination with radioactive substances;
- The design of nuclear medicine treatment rooms and rooms where radionuclide sources will be used, prepared or stored. Advice will also be given on the appropriate designation of the radiation areas in the department, as controlled or supervised areas, and any physical control measures that are required;
- The undertaking of appropriate risk assessments prior to the use of nuclear medicine equipment and appropriate emergency procedures and contingency plans, in co-operation with departmental management;
- The regular calibration and testing of radiation monitoring instruments;
- The correct use of personal protective equipment by all nuclear medicine staff;

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- The provision of radiation safety training for staff;
- The development and implementation of safe work practices when using radiation sources;
- Providing appropriate personal radiation monitors to staff;
- Maintaining radiation safety records;
- Reviewing, auditing and reporting on radiation practices to ensure their continued effectiveness;
- Providing Human Research Ethics Committees with a radiation dose estimation and risk assessment for any research study which involves the research participant receiving a radiation exposure from radioactive substances;
- Providing reports on radiation incidents to the regulatory authorities which includes what happened, estimates of radiation exposure to individuals, action taken and recommendations on how to prevent a recurrence; and
- Providing advice to his/her employer to ensure that the facility meets its obligations under the national or State legislation.

Each nuclear medicine facility will generally have a radiation safety and protection plan which documents the radiation safety program. The Radiation Safety Officer/Nuclear Medicine Physicist has a key role in the development, implementation and management of this plan.

5. RADIATION METROLOGY AND DOSIMETRY

Radiation physics is the science of ionising radiation and its interaction with matter, with particular emphasis on the energy absorbed. Radiation dosimetry entails the quantitative determination of that energy and requires a thorough knowledge of the physical processes involved. The Nuclear Medicine Physicist is responsible for the establishment and maintenance of all dosimetric standards, techniques and equipment. In addition, there is a need for nuclear medicine facilities to participate in the national dose calibrator surveys. The Nuclear Medicine Physicist must ensure that all measures of radionuclide activity are both accurate and precise.

The specific roles and responsibilities are listed below:

- Responsibility for the calibration of radionuclide dose calibrators;
- Responsibility for regular quality control of dose calibrators;
- Responsibility for in-vivo dosimetry for patients having diagnostic nuclear medicine procedures; and
- Responsibility for patient dose measurements and calculation for radionuclide therapy treatments.

6. QUALITY CONTROL, SAFETY AND MAINTENANCE OF NUCLEAR MEDICINE EQUIPMENT

Nuclear Medicine Physicists must provide a comprehensive quality control program to ensure the correct and safe functioning of all nuclear medicine, or nuclear medicine-related, equipment. This includes all radionuclide dose calibrators, counting systems, gamma cameras, PET systems, clinical network systems and in-house software. A

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comprehensive guide to the nuclear medicine physics aspects of quality control in nuclear medicine has been published by the Technical Standards Committee (TSC) of the ANZSNM (6). The TSC has also published a similar document which specifies the minimum technical performance requirements for PET scanners to be used in clinical imaging (7).

Nuclear Medicine Physicists may also be responsible for ensuring that effective planned preventative maintenance and repair arrangements are implemented. This may be carried out by manufacturers or an in-house service. In all cases the Nuclear Medicine Physicists are responsible for ensuring that adequate quality control checks are carried out following any planned preventative maintenance, upgrade or repair work, prior to the equipment being handed back for safe clinical use.

The specific roles and responsibilities of the Nuclear Medicine Physicists may be listed as follows:

- Responsibility for establishing a quality control baseline;
- Responsibility for establishing the quality control program , including:
 - frequency of checks
 - methodology, including equipment and personnel
 - provision of necessary instructions
 - tolerance and action levels
 - actions resulting
 - method of recording
- Responsibility for first-line trouble shooting of equipment problems and for liaising with the manufacturer's service representatives;
- Responsibility for withdrawing from clinical use, or imposing restrictions on, equipment deemed unsatisfactory for clinical use; and
- Key role in establishing and carrying out a planned preventative maintenance and repair service.

7. RADIONUCLIDE THERAPY USING UNSEALED SOURCES

Nuclear Medicine Physicists play a key role in the development, implementation, delivery, verification and maintenance of radionuclide therapy techniques.

The specific roles and responsibilities of the nuclear medicine physicist include:

- Ensuring the accuracy of the measured radioactivity;
- Ensuring the preparation of in-patient treatment facilities for each patient;
- Ensuring the safety of staff during the administration of the radiopharmaceutical;
- Ensuring the removal of any radioactive contamination of the treatment facilities following the discharge of the patient;
- The measurement of absorbed dose to the tumour(s) and to critical organs; and
- Providing advice on the appropriate radiation safety precautions to ensure that the patient's relatives and friends do not receive radiation doses in excess of the appropriate dose constraints.

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8. EQUIPMENT PROCUREMENT, ACCEPTANCE AND COMMISSIONING

Nuclear Medicine Physicists play a key role in the team responsible for budgeting and procurement of new equipment. This includes input into the formation of a capital equipment replacement program. Nuclear Medicine Physicists also play a key role in the planning and design of new installations, including taking responsibility for radiation protection aspects of design such as shielding requirements and safety features to comply with statutory regulations and good practice. Nuclear Medicine Physicists are responsible for the acceptance, commissioning and calibration of nuclear medicine equipment. In addition, they have a lead role in the safe and effective implementation of new or modified equipment into clinical use.

The specific roles and responsibilities are listed below:

- Key role in the scientific justification and development of business plans for nuclear medicine;
- Key role in the development of a capital equipment replacement program;
- Key role in assessing service needs;
- Lead role in preparing nuclear medicine equipment specifications;
- Lead role in the evaluation of nuclear medicine equipment, diagnostic techniques and technologies;
- Advising on service effects of procurement options;
- Lead role in the planning and design of facilities;
- Responsibility for the radiation protection aspects of the design of facilities;
- Responsibility for the radiation protection aspects of the use of the equipment;
- Responsible for co-ordination of the installation of new equipment;
- Responsible for liaising with manufacturer's installing engineers during installation;
- Responsible for acceptance testing of new or modified nuclear medicine equipment. This includes:
 - Safety testing
 - Stability testing
 - Performance acceptance testing against national standards and against selection and supply specifications
 - Establishing basic machine performance quality control baselines
 - Interfacing and integration into local clinical networks
 - Accepting all modalities, functions, systems, options and accessories prior to clinical use
- Responsibility for managing an appropriate quality control and preventative maintenance program for nuclear medicine equipment.

9. CLINICAL COMPUTING AND NETWORKING

Clinical computer networks provide the potential for significant improvements in the efficiency of the nuclear medicine departments, and facilitate image archiving and

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integration into hospital-wide PACS. Such systems enable the transfer of patient data between workstations, patient administration systems and databases; information transfer within hospital networks through dedicated gateways and archiving of data stored in the system.

Nuclear Medicine Physicists are uniquely placed in having, not only a detailed knowledge of nuclear medicine, but also an accurate understanding of what the network does and an understanding of network architecture and transmission standards necessary for understanding and developing a nuclear medicine image and data network. Nuclear Medicine Physicists should therefore take overall responsibility for the safe and accurate implementation of such technology within the nuclear medicine facility and should liaise with the institution's IT staff to ensure a satisfactory implementation.

The specific roles and responsibilities may be listed as follows:

- Responsibility for defining clinical network pathways and developing clinical network functions;
- Responsibility for assessing and evaluating clinical systems;
- Responsibility for installing, testing and commissioning clinical systems;
- Responsibility for authorising such systems as safe for clinical use;
- Manipulate medical image data in a range of standard (eg Interfile and DICOM) and non-standard formats;
- Validate clinical software using simulation, phantoms and clinical data;
- To undertake system administrator roles within the nuclear medicine facility;
- To provide beta and gamma test site facilities and undertake software evaluation of pre-clinical releases of commercial software; and
- Development of in-house software to facilitate improvements in clinical service or technique.

10. QUALITY MANAGEMENT

Nuclear Medicine Physicists have taken a key role in the development and introduction of quality assurance standards in nuclear medicine facilities nationally, in liaison with other staff groups (6). A Nuclear Medicine Physicist may have responsibility, as Quality Management Representative, for the development and maintenance of a quality system within a nuclear medicine facility.

11. TEACHING AND TRAINING

Clinical and other staff groups rely heavily on appropriately qualified Nuclear Medicine Physicists for their training in all areas of nuclear medicine physics.

Nuclear Medicine Physicists provide teaching and training for:

- Nuclear medicine physicists in training;
- Nuclear medicine specialists (physicians and radiologists) undertaking the Basic Sciences Course run by the ANZAPNM;

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- Radiology registrars under the RANZCR training program;
- Nuclear medicine technologists in training;
- In service training;
- Other health service staff, for example, in aspects of radiation protection and the use of equipment or new procedures. In particular, training may be given by nuclear medicine physicists to other health service staff in the core knowledge required by ionising radiation regulations;
- Supervision of MSc and PhD students and programs; and
- Other relevant courses including update courses, as are established by local need.

12. RESEARCH AND DEVELOPMENT

Nuclear Medicine Physicists in Australia and New Zealand are responsible for establishing high standards of research and the development, optimisation and advancement of nuclear medicine techniques. The complexity and cost of modern equipment has resulted in much implementation of research and development now being undertaken by the manufacturer, although often in close collaboration with medical physicists. However, in all cases Nuclear Medicine Physicists continue to advise on the directions of these developments. This requires a close liaison with manufacturers and therefore the Nuclear Medicine Physicist has a continuing role in the application of new technologies.

Nuclear Medicine Physicists will continue to contribute to the development of major changes in diagnostic and therapeutic techniques, and in conjunction with clinical colleagues, to patient orientated research and health technology assessment. Nuclear Medicine Physicists play a pivotal role in the translation of clinical research into routine clinical practice. This may require customization of published protocols to meet the requirements of the local medical staff or to take account of the specifications of the facility's equipment.

Nuclear Medicine Physicists may participate in clinical trials and statistical analysis of results. The ACPSEM aims to ensure that not only are medical physicists and engineers contributing to the development of new equipment and technology but also contribute, as part of a multi-disciplinary team, to the process of health technology assessment. It therefore strives not only to support research programs in medical physics and engineering, but also to ensure that genuine research skills, such as ethically approved clinical trial design, are part of a Nuclear Medicine Physicist's training and practice.

In many departments, especially those associated with teaching hospitals, medical physics staff are involved in, or responsible for, major projects and academic research. The ACPSEM encourages and supports close collaboration between clinical departments and academic centres to ensure effective and productive research programs. Involvement in research and development is essential for continuous improvement in the nuclear medicine service leading to improved clinical outcomes. Such activities are the basis for evidence-based medicine. Attendance at, and contributions to, scientific and medical meetings and publications in high quality peer reviewed journals constitute important elements of this interchange of information. There is also a requirement for staff to maintain an awareness of the

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work in other institutions in Australia and abroad through reading appropriate scientific and clinical journals and effective use of the World Wide Web.

13. REFERENCES

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