



**Roles and Responsibilities**  
**of**  
**Radiation Oncology Medical Physicists**

# Roles & Responsibilities of Radiation Oncology Medical Physicists

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# Roles & Responsibilities of Radiation Oncology Medical Physicists

## 1. INTRODUCTION

This document provides details of the roles and responsibilities of radiation oncology medical physicists. It is adapted (with permission) from an IPEM report (reference 1). Its style is intended to be non-proscriptive, partly because radiation oncology is a rapidly changing field.

The radiation oncology medical physicist is an essential member of the multi-professional team responsible for the design and delivery of radiotherapy treatment whose key roles may be summarised as:

- 1.1. Management, development and scientific direction of the radiation oncology medical physics service
- 1.2. Ensuring the accuracy of radiotherapy treatment through dose calculation procedures, radiation dosimetry and of ongoing quality control of equipment
- 1.3. Participation in the planning and delivery of patient treatments
- 1.4. Design and implementation of new and innovative treatments
- 1.5. Leadership of research and development, especially in the technological basis of radiotherapy
- 1.6. Providing advice on appropriate treatment techniques
- 1.7. Ensuring radiation safety for the patient, staff and the public
- 1.8. Management of computer systems and software design and development
- 1.9. Management and procurement of radiotherapy equipment
- 1.10. Teaching and training of staff (including medical physicists, technicians, doctors, radiation therapists, nurses).

The roles and responsibilities of radiation oncology medical physicists in radiation oncology are diverse, demanding and pivotal for the safe and effective delivery of radiation treatments to cancer patients. Radiation oncology medical physicists apply their knowledge of mathematics, physics and technology to establish, implement and monitor processes which allow optimal treatment, taking account of the radiation protection of the patients and others. Radiation oncology medical physicists are responsible for ensuring that the equipment, systems and processes used in treatment planning & delivery will produce the desired dose distribution in the patient with acceptable accuracy assuming that they are applied correctly by the radiation therapists.

Radiation oncology medical physicists are involved in both patient related activities and in the development, implementation, maintenance and quality control of the infrastructure (facilities, equipment & computer systems) and processes necessary for the provision of radiation treatments. 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 radiotherapy. This also requires an understanding of the physical principles of the generation and shaping of photon and electron beams.

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Radiation oncology medical physicists have the ability to critically assess faults, and assign tolerances, test frequencies and remedial action. The decision to hand over a piece of therapy equipment for clinical use after a repair which might affect the clinical accuracy of the equipment must be made by a radiation oncology medical physicist in consultation with the radiation therapist and/or service personnel carrying out the repair. This may require a balanced judgement between the need to deliver treatment to patients and the need for treatment accuracy.

The accurate delivery of a radiation dose requires many complex processes, the accuracy of which can only be guaranteed by a thorough understanding of the underlying physics and computer algorithms being used. The scientific integrity and accuracy of treatment planning cannot be delegated to other staff groups whose training in the physical sciences is less rigorous.

One of the most critical factors in modern radiotherapy is the accurate localisation of the target volume at the isocentre of the treatment machine. The radiation oncology medical physicist's skills, especially the understanding of error analysis, should be fully employed in ensuring that the methods used for patient positioning and portal verification are appropriate. It should be noted that the giving of appropriate advice often involves direct patient contact.

### **2. AREAS OF RESPONSIBILITY IN RADIATION ONCOLOGY**

Thirteen broad areas can be identified where radiation oncology medical physicists have a distinct role. They are:

- 2.1. Management, scientific responsibility, advice and direction
- 2.2. Equipment procurement, acceptance and commissioning
- 2.3. Radiation dosimetry
- 2.4. Scientific integrity and accuracy of external beam treatment planning, delivery and verification processes (including optimisation and safety)
- 2.5. Use of imaging techniques in treatment planning and treatment verification
- 2.6. Radiation protection
- 2.7. Quality control, safety and maintenance of radiation oncology equipment
- 2.8. Brachytherapy including the scientific integrity and accuracy of treatment planning, delivery and verification processes (including optimisation and safety)
- 2.9. Unsealed sources
- 2.10. Specialised treatment techniques
- 2.11. Computing and networking
- 2.12. Quality management
- 2.13. Teaching and training
- 2.14. Research and development

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## **3. EQUIPMENT PROCUREMENT, ACCEPTANCE AND COMMISSIONING**

Radiation oncology medical physics staff 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 programme. Radiation oncology medical physics staff 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. The radiation oncology medical physicist is responsible for the acceptance, commissioning and calibration of radiation oncology 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:

- 3.1. Key role in the scientific justification and development of business plans for radiation oncology
- 3.2. Key role in the development of a capital equipment replacement programme
- 3.3. Key role in assessing service needs
- 3.4. Lead role in preparing radiation oncology equipment specifications
- 3.5. Lead role in evaluating radiation oncology equipment, treatment techniques and technologies
- 3.6. Advising on specifications for radiation oncology related imaging equipment e.g. CT scanners, MRI systems, PET systems
- 3.7. Advising on service effects of procurement options
- 3.8. Lead role in the planning and design of installations
- 3.9. Responsibility for the radiation protection aspects of design.
- 3.10. Responsible for co-ordination of the installation.
- 3.11. Responsible for liaising with manufacturers' installing engineers during installation
- 3.12. Responsible for acceptance testing of new or modified radiation oncology equipment. This includes:
  - 3.12.1. Safety testing
  - 3.12.2. Involvement in critical examination as required by State, Territory and national ionising radiation regulations
  - 3.12.3. Stability testing
  - 3.12.4. Performance acceptance testing against national standards and against selection and supply specifications
  - 3.12.5. Establishing basic machine performance quality control baselines
  - 3.12.6. Interfacing and integration into local computer networks
  - 3.12.7. Accepting all modalities, functions, systems, options and accessories prior to clinical use
- 3.13. Responsible for commissioning of radiation oncology equipment. This

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includes:

- 3.13.1. The measurement of all data required for the treatment planning computer
- 3.13.2. The measurement of data required for data tables and calculations
- 3.13.3. The measurement of check data to confirm the accuracy of the treatment planning computers and systems
- 3.13.4. The measurement of parameters to determine a baseline for ongoing quality assurance tests
- 3.13.5. The definitive calibration of treatment units.

### **4. RADIATION 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 radiation oncology medical physicist is responsible for the establishment and maintenance of all dosimetric standards, techniques and equipment. In addition, there is a need for radiation oncology centres to participate in the national and international dosimetry audit scheme. The requirement for accuracy and dosimetric precision in radiation oncology with regard to tumour control probability and normal tissue complication probability is well known.

The specific roles and responsibilities are listed below:

- 4.1. Responsibility for the calibration, including the definitive calibration, of dosimeters
- 4.2. Responsibility for regular quality control of dosimeters
- 4.3. Responsibility for the calibration, including the definitive calibration, of treatment units, i.e. calibration of dose monitor or timer, traceable to national standards
- 4.4. Responsibility for implementation of dosimetry Codes of Practice
- 4.5. Responsibility for participating in national and international dosimetry audit schemes
- 4.6. Responsibility for in-vivo dosimetry
- 4.7. Responsibility for dosimetry measurements for calibration of brachytherapy sources
- 4.8. Responsibility for patient dose calculation for brachytherapy treatments.

### **5. EXTERNAL BEAM TREATMENT PLANNING, DELIVERY AND VERIFICATION.**

The complexity of treatment planning is increasing, with 3D treatment planning and conformal therapy becoming standard. The use of new treatment planning optimisation techniques (inverse planning) leading to the delivery of complex

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treatments with Intensity Modulated Radiation Therapy beams (IMRT) is becoming increasingly common. Safe and effective treatment planning therefore relies on a thorough understanding of radiation and its interactions in and with patients' tissues, the dose calculation and optimisation algorithms, competence in the use of advanced software tools and knowledge and appreciation of the inherent limitations in accuracy of any treatment planning system. Therefore the radiation oncology medical physicist must take overall scientific responsibility for the treatment planning process.

The specific roles and responsibilities are listed below;

- 5.1. Commissioning of treatment planning systems, including establishment of accuracy and overall limitations of the systems
- 5.2. Validation of the electronic transfer of patient and treatment data between CT, planning computer and treatment unit (e.g. using DicomRT)
- 5.3. Overall scientific responsibility for the treatment planning process, including advising on all aspects of patient dosimetry including the optimisation and safety of treatment and treatment planning
- 5.4. Calculation of monitor units when required
- 5.5. Development of independent method of checking monitor unit calculations provided by the treatment planning computer
- 5.6. Ad hoc provision of radiation beam data required to plan individual patient treatments
- 5.7. Involvement in treatment planning for patients where non-standard treatment techniques are required or where modification of an existing treatment technique is required.
- 5.8. Treatment planning quality assurance
- 5.9. Validation of treatment plan calculations by radiation dosimetry measurements
- 5.10. Verification of patient treatment delivery using in-vivo dosimetry
- 5.11. Development, implementation and analysis of in vivo dosimetry and portal imaging systems
- 5.12. Design and production of machine specific treatment accessories
- 5.13. To provide advice on radiobiological models for alternative fractionation schemes and compensation for gaps in treatment
- 5.14. A key role in the development and implementation of new treatment techniques

## **6. RADIATION PROTECTION**

There are legal requirements on a radiation employer to ensure the radiation safety of patients, members of the public and staff by employing appropriately qualified and trained medical physics staff. The legal framework for these requirements is contained in State and Territory ionising radiation regulations and codes of practice.

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The main duty holders under these regulations for radiation oncology facilities are radiation oncology medical physicists. One or more, where appropriate, must be closely involved in every radiation oncology practice or procedure.

This will include:

- 6.1. Advising on the radiation safety of individual patients undergoing radiation oncology. Particular emphasis is placed on minimising the dose to organs at risk, particularly the foetus, the gonads of patients of reproductive capacity and organs at particular risk such as the spinal cord and eyes.
- 6.2. Responsibility for supervising the installation, safety testing, commissioning and calibration of new radiation oncology equipment
- 6.3. Responsibility for ensuring the regular calibration of all dosimetry systems associated with radiation oncology equipment
- 6.4. Responsibility for managing an appropriate quality control and preventative maintenance programme for radiation oncology equipment
- 6.5. Advising on the safety and implementation of new radiation treatment techniques and imaging procedures
- 6.6. Advising on the optimisation of treatment plans to achieve the best possible outcome for the patient
- 6.7. Responsibility for maintaining an inventory of radiation equipment
- 6.8. Responsibility for maintaining records of radionuclides used and for monitoring their safety.
- 6.9. Responsibility for giving advice on the discharge of patients whom have been treated with radionuclides and advice on the disposal of corpses containing radionuclides.
- 6.10. The administration of appropriate authorisations for the use of radionuclides within the radiation oncology department and giving advice.
- 6.11. Carry out any measurements, investigations or assessments which are deemed necessary to verify radiation safety or a radiation incident;

The radiation employer should appoint a radiation safety officer for radiation oncology. This is a radiation oncology medical physicist with appropriate training and considerable experience in radiation oncology safety. This person must be consulted on or give advice on or be responsible for:

- 6.12. The design of radiation oncology 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.
- 6.13. Appropriate risk assessments prior to the use of radiation oncology equipment and appropriate emergency procedures and contingency plans, in co-operation with departmental management.
- 6.14. Ensure that a critical examination of new radiation oncology equipment is carried out.

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- 6.15. Requirements for the regular calibration and testing of radiation monitoring instruments
- 6.16. The use of personal protective equipment
- 6.17. Radiation safety training for staff.
- 6.18. Safe work practices when using radiation sources
- 6.19. Supervising the experimental monitoring of radiation exposure to staff
- 6.20. Maintaining radiation safety records
- 6.21. Reviewing, auditing and reporting on radiation practices to ensure their continued effectiveness
- 6.22. Provide 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.

Each radiation oncology facility will generally have a radiation safety and protection plan which documents the radiation safety program. The radiation safety officer has a key role in the development, implementation and management of this plan.

### **7. QUALITY CONTROL, SAFETY AND MAINTENANCE OF RADIATION ONCOLOGY EQUIPMENT**

A vital component of the radiation oncology medical physics service involves the provision of comprehensive quality control programmes to ensure the correct and safe functioning of all radiation oncology, or radiation oncology-related, equipment. This includes all treatment units, radiation oncology imaging devices such as simulators, CT equipment and MRI scanners, treatment planning computers, dosimetry equipment, brachytherapy devices, network systems, treatment verification systems, and in-house software. A comprehensive guide to the radiation oncology medical physics aspects of quality control in radiation oncology has been published by the ACPSEM (1). The radiation oncology medical physics service 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 radiation oncology medical physicist is 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 service may be listed as follows

- 7.1. Responsibility for establishing a quality control baseline.
- 7.2. Responsibility for establishing the quality control programme , including
  - 7.2.1. frequency of checks
  - 7.2.2. methodology, including equipment and personnel
  - 7.2.3. provision of necessary instructions
  - 7.2.4. tolerance and action levels

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7.2.5. actions resulting

7.2.6. method of recording

7.3. Responsibility for ensuring that all equipment associated with radiation simulation and treatment is safe for clinical use

7.4. Responsibility for withdrawing from clinical use, or imposing restrictions on, equipment deemed unsatisfactory for clinical use

7.5. Key role in establishing and carrying out a planned preventative maintenance and repair service

### **8. BRACHYTHERAPY**

Radiation oncology medical physicists have a key role in the commissioning and use of sophisticated remote afterloading treatment hardware and software. To ensure accuracy and safety in brachytherapy treatment planning and delivery, radiation oncology medical physicists work in close collaboration with radiation oncologists, radiation therapists and nursing staff. The following lists specific responsibilities in brachytherapy planning and delivery:

8.1. Establishment of local procedures for the implementation of dosimetry systems for intracavitary and interstitial brachytherapy treatments.

8.2. Overall responsibility for radioactive source strength confirmation/calibration and issuing of appropriate source data for clinical use.

8.3. Acquisition of patient data, computerised treatment planning and calculation of treatment times.

8.4. Development of independent methods for checking treatment times.

8.5. Manual handling of sources.

8.6. Source custodian duties, including stock control, documentation, compliance with relevant legislation

8.7. Routine quality control checks e.g. positional accuracy (in the case of remote afterloading equipment) prior to patient treatment, source activity checks and leakage testing.

8.8. Responsibility for quality assurance of planning system, and for imaging equipment used for source localisation (e.g. ultrasound, CT scanner etc)

8.9. Radiobiological equivalence calculations of protracted brachytherapy to fractionated external beam treatments to assist clinical oncologists in their choice of treatment regime.

8.10. Design of special brachytherapy treatment arrangements, such as ophthalmic treatments.

8.11. Design and construction of sealed source applicators for specialised treatments or for individual patients.

8.12. Development and introduction of new treatment techniques into clinical practice

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## **9. UNSEALED SOURCES**

An appropriately qualified medical physicist is responsible for the supervision of therapeutic uses of radionuclides as prescribed by the consultant oncologist. In Australia this is most likely to be a medical physicist qualified in nuclear medicine physics but may be a radiation oncology medical physicist with appropriate training in nuclear medicine. This will include

- 9.1. Practical advice on radiation protection of other staff (especially nursing staff)
- 9.2. Procurement and stock control
- 9.3. Calibration and measurement of required radionuclides
- 9.4. Where necessary calculation of patient radiation dose and advice on the prescribed activity
- 9.5. Advice on administration procedures
- 9.6. Maintenance of records

## **10. SPECIALISED TREATMENT TECHNIQUES**

Radiation oncology medical physics staff play a key role in the development, implementation, delivery, verification and maintenance of specialised treatment techniques.

Such specialised treatment techniques include but are not limited to:

- 10.1. Stereotactic radiotherapy
- 10.2. Intensity modulated radiotherapy (IMRT)
- 10.3. Total skin electron techniques
- 10.4. Total body irradiation techniques
- 10.5. Proton therapy
- 10.6. Cardiovascular brachytherapy
- 10.7. Ultrasound guided prostate brachytherapy
- 10.8. Targeted radiation oncology using unsealed sources

## **11. COMPUTING AND NETWORKING**

Computer networking provides the potential for significant improvements in the efficiency of the radiation oncology process, thereby helping to minimise the occurrence of errors. Such systems provide recording and verification of treatments; setting and verification of multileaf collimators and rotation therapy; transfer of patient and treatment planning data between machines, patient administration systems and databases; information transfer with hospital networks through dedicated gateways; archiving of data stored in the system; transfer of diagnostic, planning and verification images; and processing of portal images.

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Radiation oncology medical physics staff are uniquely placed in having, not only a detailed knowledge of radiation oncology, 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 radiation oncology image and data network. Radiation oncology medical physics staff should therefore take overall responsibility for the safe and accurate implementation of such technology.

The specific roles and responsibilities may be listed as follows:

- 11.1. Responsibility for defining network pathways and developing network functions
- 11.2. Responsibility for assessing and evaluating systems
- 11.3. Responsibility for installing, testing and commissioning systems
- 11.4. Responsibility for authorising such systems as safe for clinical use
- 11.5. To undertake system administrator roles
- 11.6. To provide beta and gamma test site facilities and undertake software evaluation of pre-clinical releases of commercial software
- 11.7. Development of in-house software to facilitate improvements in service or technique

### **12. QUALITY MANAGEMENT**

Radiation Oncology medical physics staff have taken a key role in the development and introduction of quality assurance standard in radiation oncology departments nationally, in liaison with other staff groups (1,2). A member of the radiation oncology medical physics staff may have responsibility, as Quality Management Representative, for the development and maintenance of a quality system within a radiation oncology medical physics department.

### **13. TEACHING AND TRAINING**

Clinical and other staff groups rely heavily on appropriately qualified radiation oncology medical physics staff for their training in all areas of radiation oncology medical physics.

Radiation oncology medical physics staff provide teaching and training for:

- 13.1. Radiation oncology medical physicists in training
- 13.2. Clinical oncologists undertaking the examination for Fellowship of the RANZCR
- 13.3. Radiation therapists in training
- 13.4. In service training
- 13.5. 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 radiation oncology medical physicists to other health service staff in the core

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knowledge required by ionising radiation regulations.

13.6. Supervision of M.Sc. and Ph.D. programmes

13.7. Other relevant courses including update courses, as are established by local need

### **14. RESEARCH AND DEVELOPMENT**

Radiation oncology medical physicists are responsible for establishing high standards of dosimetry and the development, optimisation and advancement of radiation oncology treatment techniques. They also contribute vital work on the design and development of treatment machines, simulators, treatment planning systems and other ancillary equipment. 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 physics departments. However, in all cases radiation oncology medical physicists continue to advise on the directions of these developments and their integration into the planning and delivery of the radiation treatment of the patient. This requires a close liaison with manufacturers and therefore the radiation oncology medical physicist has a continuing role in the application of new technologies.

The radiation oncology medical physicists will continue to contribute to the understanding of the interaction of radiation with patients, to the development of major changes in treatment modalities and, in conjunction with clinical and radiation therapy colleagues, to patient orientated research and health technology assessment. This may involve participation in clinical trials and statistical analysis of results. 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 programmes in medical physics and engineering in cancer, but also to ensure that genuine research skills, such as ethically-approved clinical trial design, are part of a radiation oncology medical physicists 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 programmes. Involvement in research and development is essential for continuous improvement in the radiation oncology 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 work in other institutions in Australia, New Zealand and abroad through reading appropriate scientific and clinical journals and effective use of the World Wide Web.

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## **15. REFERENCES**

1. "Guidelines for the Provision of Physics Service to Radiotherapy", Institute of Physics & Engineering in Medicine, 2001
2. ACPSEM Position Paper, "Recommendations for the Safe Use of External Beams and Sealed Brachytherapy Sources in Radiation Oncology", Aust. Phys. & Eng. Sci. Med. Vol. 20, No. 3 Sup., 1997
3. "Comprehensive QA for radiation oncology: Report of AAPM Radiation Therapy Committee Task Group 40." Med. Phys., 21 581-618, 1994