IPEM

POLICY STATEMENT:

Recommendations for the Provision of a Physics Service to Radiotherapy

1. Introduction

The IPEM recommendations for the provision of a physics service to radiotherapy are recognised as a benchmark for minimum staffing guidance [1-3]. Since the publication of previous guidance over seven years ago [4], radiotherapy has seen a large increase in complexity, with intensity-modulated radiotherapy (IMRT), rotational modulated techniques (VMAT and Tomotherapy) and high accuracy hypo-fractionated treatments such as Stereotactic Body Radiotherapy (SBRT or SABR) in widespread clinical use in the UK. This has been underpinned by greater availability and use of image-guidance equipment and tools. As noted in the last report, advanced equipment of increasing complexity requires appropriate levels of support by Clinical Scientists, physics and engineering technologists, guided by Medical Physics Experts (MPE) and Radiation Protection Advisers (RPA). This is to ensure advanced technology is safely and effectively used for the benefit of patients undergoing radiotherapy treatments.

This document seeks to address the current issues and gives updated guidance on the provision of a physics service to radiotherapy. Although the document provides guidance on the number of Clinical Scientists, physics and engineering technologists required to provide a safe radiotherapy service, it should be understood that increased levels of skill-mix can be applied to individual departments depending on local work practices and circumstances. Descriptions of the role of a Clinical Scientist and technologist in radiotherapy can be found in the accompanying policy statement [5].

2. Minimum Staffing Requirements

The minimum number of physics staff required for the provision of a physics service to radiotherapy departments depends upon:

- the amount and complexity of equipment used;
- the number of patients treated and the complexity of treatments;

- departmental working arrangements.

Staffing levels may be calculated from Table 1. For each component, the number of items applying to the department should be multiplied by the number of WTE staff per item to give the number of physics staff for that component. The number of staff for each of the eleven components should then be summed.

Table 1: Minimum Staffing Requirements for a Routine Physics Service to Radiotherapy.

Unit	Item	WTE Clinical Scientists	WTE Technologists	
			Physics	Engineering
Equipment dependent factors				
1	Multi-mode accelerator (including electrons and/or FFF)	1.0	0.5	1.2
1	Single-mode accelerator (including Tomotherapy, CyberKnife or Gamma knife)	0.8	0.4	1.0
1	Major item	0.2	0.2	0.2
1	Minor item	0.1	0.1	0.1
Patient dependent factors				
100	New courses treated p.a. by simple palliative or conformal external beam therapy	0.1	0.2	0.01
100	New courses treated p.a. by IMRT/VMAT	0.2	0.3	0.01
100	New courses treated p.a. by brachytherapy	0.4	0.4	0.01
100	New courses treated p.a. by special techniques	0.3	0.4	0.01
Departmental Factors				
1	Radiation protection (not RPA)	0.1	-	-
1	Accredited quality system	0.5	-	-
1	Clinical trials support	0.5	-	-

The number of engineering technologists required will depend on the extent to which maintenance is carried out in-house or by external service contracts. <u>Recommended numbers assume full first and second line maintenance is carried out in-house.</u> Even where there is a fully comprehensive and externally resourced service contract it is recommended that a facility for first line repair and quality control is provided in-house for efficient fault finding/rectification.

Linear accelerators are assumed to be equipped with MLCs, portal imagers (EPID) and IGRT systems e.g. kV CBCT. Linear accelerators without IGRT equipment are likely to be of an advanced age (>10 years) and therefore will have increased maintenance requirements.

<u>Major items</u> include: dedicated CT or MRI scanners, treatment planning systems (TPS), HDR/PDR units, radiotherapy specific PACS and oncology management systems (R&V).

Minor items include: a secondary standard, orthovoltage/superficial units, stereotactic radiotherapy equipment (e.g. micro-MLC), 6-degrees of freedom couch, 4DCT or 4D-CBCT hardware (e.g. Varian RPM system; Anzai respiratory gating system) , additional in-room imaging equipment (e.g. ExacTrac), 3D verification devices (e.g. Delta4, Octavius etc.), EPID dosimetry systems, brachytherapy ultrasound, *in vivo* dosimetry systems (e.g. TLDs, diodes) or independent Monitor unit checking software systems

Brachytherapy includes HDR/PDR after-loading, prostate seed (or other) permanent implants, and radioisotope therapies (where performed by radiotherapy physics).

Special techniques include TBI, stereotactic radiotherapy (SBRT/SRS), total skin electron techniques (TSET), intraoperative radiotherapy (IORT).

3. Absolute minimum numbers

If the number of Clinical Scientists calculated from the table is less than three then, in order to cover for absences, the establishment should be made up of at least three individuals. Each of these should be a radiotherapy physicist, but one may have some responsibilities in other areas of medical physics. Similarly, the number of technologists must be adequate to cover for absences.

At the start of the procurement process a significant time is required to appropriately specify and evaluate a major piece of equipment and the resource required for this activity should not be underestimated. Once the equipment is installed, acceptance testing and commissioning is required. Two whole time equivalent staff are required to ensure this is undertaken in a timely manner (e.g. 4-6 weeks for a matched machine, 6-10 weeks for a new model), and to ensure the integrity of the process. However, this time is highly dependent upon factors such as access to the machine and commissioning equipment, number of planning systems to commission, clinical techniques to test and validate (such as VMAT, SBRT, TBI, TSET), back-fill to the clinical service to release dedicated commissioning staff, etc.

In all departments it is recommended that there must be at least two Clinical Scientists qualified as Medical Physics Experts (MPE). At least one of these should be appointed at Consultant Clinical Scientist level, to be Head of, and be professionally accountable for, the Physics service. An MPE should be available for advice, at least by telephone, at all times that radical radiotherapy patients are treated.

4. Further considerations

The numbers indicate staffing requirements to allow for provision of a service during a standard 8-hour working day. Additional resources would be required to account for extended working hours and/or weekend working for treatment, planned preventative maintenance, repair or quality assurance work. Whilst it is not possible to provide a general recommendation, it should be noted that extended day working is potentially much less efficient [6]. In addition, the need for senior staff and Medical Physics Expert cover at all times should be considered.

The factors in Table 1 include provision for the limited amount of development work that is necessary to maintain a contemporary routine service. However, specific research and development programmes leading to new services or techniques will require additional resources, which should be specifically resourced.

The figures given in Table 1 are for fully trained staff. Staff that are not registered Clinical Scientists require supervision and training. Additional staffing is required for this task. Where departments provide significant training in addition to that required for state registration, or to ensure the competence of staff within the radiotherapy department, additional resources should be made available.

No specific consideration has been given to local circumstances such as multi-sited organisations. In such arrangements it may be appropriate to treat each site as an independent centre for staffing calculation purposes, with some economy of scale possible, depending upon the size and location of the host centre. The advice of the local Head of Medical Physics should be sought.

Although not routinely covered in the training of Clinical Scientists, appropriately trained individuals can provide valuable advice on the radiobiological effects of gaps in treatment and alternative fractionation regimes. At all times the responsibility for changes in the fractionation schedule including compensation for treatment gaps resides with the clinical oncologist authorizing the treatment.

It is important for all healthcare professionals to maintain and develop their skills and knowledge throughout their career. In recognition of this the Health and Care Professions Council (HCPC) requires all registrants to undertake a range of CPD activities. All staff should have time within their job plans allocated for CPD (e.g. 0.5 days per week), although this may take the form of in-house training, technique and service development projects to meet the needs of the department.

In very large departments there may be economies of scale, but local conditions such as extended working hours, a significant research or teaching workload, or a diverse equipment base will reduce the economies expected.

5. Skill-mix

Skill-mix patterns in radiotherapy departments have evolved over many years and are largely based on the ease of recruiting different staff groups in different parts of the country, as well as on the personalities who influenced the setting up of different departments. A joint document from the RCR, SCoR, RCN and IPEM described some of the issues [7] and it should be noted that although Table 1 above clearly demarcates the different staff groups, in practice physics and engineering technologists can, with appropriate training and support, be employed to perform tasks traditionally associated with Clinical Scientists. For example, clinical computing support for radiotherapy systems may be provided by computer engineers specialising in computerised medical devices. Treatment planning may be supported by Clinical Scientists, clinical technologists, or Radiographers or a combination of all three professional groups. Flexibility can be applied to the staffing numbers given by table 1 to provide an estimate of the size of the required workforce and then models of skill-mix applied to the number of Clinical Scientists, Radiographers, physics and engineering technologists employed in practice.

6. Risks of sub-minimal staffing levels

The multi-professional report "Toward Safer Radiotherapy" [2] recommends that departments review their staff levels at intervals of no more than two years and ensure compliance with national guidance. However, recent surveys of the radiotherapy workforce have shown a shortfall in training of new entrants, and vacancy rates across all three staff groups of 8-9% [8]. Expansion of services, introduction of proton therapy centres, and a move towards extended working hours will increase demand by a projected further 5%.

It is important to understand the consequences of inadequate staffing levels. For whatever size department, the minimum physics service must be the provision of a radiation dosimetry service for radiotherapy, maintenance of the equipment, support of routine radiotherapy planning, and adequate MPE support. Inadequate staff resources may directly impact on the quantity and quality of the service provided to the patients, oncologists and Radiographers within a department. In particular, inadequate staffing may lead to increased waiting times for cancer treatments, thereby compromising an individual patient's probability of disease free survival. Where there is a shortfall of staff compared to the guidelines outlined above there is a potential for:

- under usage of expensive therapy equipment, thereby depriving patients of state-of-the-art care;
- an increase in the likelihood of errors by a group of staff who have a determining effect on the accuracy and safety of radiation treatment to a large number of patients.

Patients are put at an increased level of risk in departments operating at staff levels well below national guidance for prolonged periods of time. Departments in this situation should therefore ensure that robust risk management is in place to reduce the risk posed by understaffing over a reasonable timescale.

7. Example calculations

Table 2: Example staffing calculation for a **small department**.

Quantity	Item	WTE Clinical Scientists	WTE Physics Technologists	WTE Engineering Technologists
3	Multi-mode accelerators	***3.0***	***1.5***	***3.6***
0	Single-mode accelerators	-	-	-
1	Major item (CT scanner)	***0.2***	***0.2***	***0.2***
1	Major item (TPS)	***0.2***	***0.2***	***0.2***
1	Major item (R&V)	***0.2***	***0.2***	***0.2***
1	Minor item (Superficial unit)	***0.1***	***0.1***	***0.1***
1	Minor item (Independent MU software)	***0.1***	***0.1***	***0.1***
1	Minor item (Diode system)	***0.1***	***0.1***	***0.1***
1	Minor item (EPID dosimetry)	***0.1***	***0.1***	***0.1***
1	Minor item (3D verification device)	***0.1***	***0.1***	***0.1***
1000	New courses treated p.a. by simple palliative or conformal external beam therapy	***1.0***	***2.0***	***0.1***
600	New courses treated p.a. by IMRT/VMAT	***1.2***	***1.8***	***0.06***
0	New courses treated p.a. by brachytherapy	-	-	-
0	New courses treated p.a. by special techniques	-	-	-
1	Radiation protection (not RPA)	***0.1***	-	-
1	Accredited quality system	***0.5***	-	-
1	Clinical trials support	***0.5***	-	-
	Total	***7.4***	***6.4***	***4.9***

Table 3: Example staffing calculation for a **medium-large department**.

Quantity	Item	WTE Clinical Scientists	WTE Physics Technologists	WTE Engineering Technologists
4	Multi-mode accelerators	***4.0***	***2.0***	***4.8***
4	Single-mode accelerators	***3.2***	***1.6***	***4.0***
2	Major item (CT scanner)	***0.4***	***0.4***	***0.4***
2	Major item (TPS)	***0.4***	***0.4***	***0.4***
1	Major item (HDR)	***0.2***	***0.2***	***0.2***
1	Major item (R&V)	***0.2***	***0.2***	***0.2***
1	Minor item (Secondary standard)	***0.1***	***0.1***	***0.1***
1	Minor item (Brachy. ultrasound)	***0.1***	***0.1***	***0.1***
1	Minor item (Independent MU software)	***0.1***	***0.1***	***0.1***
2	Minor item (3D verification devices)	***0.2***	***0.2***	***0.2***
1	Minor item (in-vivo diodes)	***0.1***	***0.1***	***0.1***
2	Minor item (4D-CT)	***0.2***	***0.2***	***0.2***
2	Minor item (4D-CBCT)	***0.2***	***0.2***	***0.2***

2	Minor item (6-DOF couch)	***0.2***	***0.2***	***0.2***
3700	New courses treated p.a. with simple palliative or conformal external beam therapy	***3.7***	***7.4***	***0.37***
1000	New courses treated p.a. by IMRT/VMAT	***2.0***	***3.0***	***0.10***
400	New courses treated p.a. by brachytherapy (gynae HDR, prostate seeds)	***1.6***	***1.6***	***0.04***
100	New courses treated p.a. by special techniques (SABR, TBI)	***0.3***	***0.4***	***0.01***
1	Radiation protection (not RPA)	***0.1***	-	-
1	Accredited quality system	***0.5***	-	-
	Total	***17.8***	***18.4***	***11.7***

References

[1] Standard 5/12, Manual of Cancer Services Standards (2000) (NHS Executive publication).

[2] Joint Report by The Royal College of Radiologists (RCR), Society and College of Radiographers (SCoR), Institute of Physics and Engineering in Medicine (IPEM), National Patient Safety Agency (NPSA), British Institute of Radiology (BIR) (2008). Towards Safer Radiotherapy. (RCR: London BFCO(08)1).

[3] Measure 10-3T-129, National Cancer Peer Review Programme Manual for Cancer Services 2013: Radiotherapy Measures. (DH Publication).

[4] Institute of Physics in Engineering & Medicine (IPEM) (2009). Policy Statement on Recommendations for the Provision of a Physics Service to Radiotherapy (IPEM: York).

[5] Institute of Physics in Engineering & Medicine (IPEM) (2017). IPEM Policy Statement: The Roles of the Scientist and Technologist in Radiotherapy Physics (IPEM: York).

[6] Institute of Physics in Engineering & Medicine (IPEM) (2014). IPEM Position Statement: Impact of Extended Clinical Hours on a Radiotherapy Physics Service (IPEM: York).

[7] The Royal College of Radiologists (RCR), The Society and The College of Radiographers (SCoR), The Royal College of Nursing (RCN), The Institute of Physics and Engineering in Medicine (IPEM) (2002). Breaking the Mould: Roles, Responsibilities and Skills Mix in Departments of Clinical Oncology (RCR: London).

[8] Institute of Physics in Engineering & Medicine (IPEM) (2016). IPEM Position Statement on the Radiotherapy Physics Workforce (IPEM: York).

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