RESULTS FROM AN EANM SURVEY ON TIME ESTIMATES AND PERSONNEL RESPONSIBLE FOR MAIN TASKS IN MOLECULAR RADIOTHERAPY DOSIMETRY

Pablo Mínguez Gabiña[1,2], Katarina Sjögreen Gleisner[3], Marta Cremonesi[4], Caroline Stokke[5,6], Glenn Flux[7], Francesco Cicone[8,9], Mark Konijnenberg[10,11], Matt Aldridge[12], Mattias Sandstrom[13], Carlo Chiesa[14], Maria Paphiti[15], Eero Hippeläinen[16], Carlos Uribe[17,18], Pavel Solny[19], Silvano Gnesin[20], Peter Bernhardt[21,22], Nicolas Chouin[23], Pedro Fragoso Costa[24, 25], Gerhard Glatting[26], Frederik Verburg[10] and Jonathan Gear[7]

[1]Department of Medical Physics and Radiation Protection, Gurutzeta-Cruces University Hospital/ Biocruces Bizkaia Health Research Institute, Plaza Cruces s/n, 48903 Barakaldo, Spain.
[2]Faculty of Engineering, Department of Applied Physics, UPV/EHU, Bilbao, Spain
[3]Medical Radiation Physics, Lund University, Lund, Sweden
[4]Radiation Research Unit, Department of Medical Imaging and Radiation Sciences, Istituto Europeo di Oncologia, Milano, Italy
[5]Department of Physics and Computational Radiology, Division of Radiology and Nuclear Medicine, Oslo University Hospital, Oslo, Norway
[6]Department of Physics, University of Oslo, Oslo, Norway
[7]Joint department of Physics, Royal Marsden NHSFT and Institute of Cancer Research, Sutton, UK
[8]Department of Experimental and Clinical Medicine, “Magna Graecia” University of Catanzaro, Catanzaro, Italy
[9]Nuclear Medicine Unit, University Hospital “Mater Domini”, Catanzaro, Italy
[10]Department of Radiology & Nuclear Medicine, Erasmus MC, Rotterdam, The Netherlands
[11]Department of Medical Imaging, Radboud University Medical Center, Nijmegen, The Netherlands
[12]Maidstone and Tunbridge Wells NHS Trust, Maidstone Hospital, ME16 9QQ
[13]Section of Nuclear Medicine and PET, Department of Surgical Sciences, Uppsala University, Uppsala, Sweden,
[14]Nuclear Medicine Division, Foundation IRCCS Istituto Nazionale Tumori, via Giacomo Venezian 1, 20133 Milano, Italy
[15]Medical Physics Department, Pammakaristos Hospital of Divine Providence, Iakovaton 43, Athens 11144, Greece
[16]Department of Clinical Physiology and Nuclear Medicine, University of Helsinki and Helsinki University Hospital, Helsinki, Finland
[17]Functional Imaging, BC Cancer, Vancouver, British Columbia, Canada
[18]Department of Radiology, University of British Columbia, Vancouver, British Columbia, Canada
[19]National Radiation Protection Institute, Bartoskova 1450/28, 140 00 Praha 4 – Nusle, Czech Republic
[20]Institute of Radiation Physics, Lausanne University Hospital, University of Lausanne, Lausanne, Switzerland
[21]Department of Medical Radiation Sciences, Institute of Clinical Sciences, Sahlgrenska Academy at University of Gothenburg, Gothenburg, University, Gothenburg, Sweden
[22]Department of Medical Physics and Biomedical Engineering (MFT), Sahlgrenska University Hospital, Gothenburg, Sweden

[23]Nantes Université, Inserm, CNRS, Université d'Angers, Oniris, CRCI2NA, Nantes - France
[24]Department of Nuclear Medicine, West German Cancer Center, University of Duisburg-Essen and German
[25]Cancer Consortium (DKTK)-University Hospital Essen, Essen, Germany
[26]Medical Radiation Physics, Department of Nuclear Medicine, Ulm University, Ulm, Germany

Abstract

Background: There is a need to understand the resources required to implement dosimetry in the field of molecular radiotherapy (MRT). This study reports on the time currently dedicated to separate MRT dosimetry tasks, and the personnel category that are responsible for those tasks.

Methods: An electronic questionnaire was distributed among experts working in MRT with 39 questions on time estimates and 24 questions on personnel responsible for the main tasks in MRT dosimetry. The survey was divided into three main sections corresponding to the principal stages of dosimetry in MRT: protocol development; initial set-up of the equipment; and patient dosimetry. For the equipment, portable radiation detectors, gamma well counters and liquid scintillation counters, thyroid uptake probes and SPECT/CT and PET/CT scanners were considered, and for patient dosimetry, whole-body, blood, thyroid and image-based dosimetry.

Results: The survey was completed by 19 medical physicists and two nuclear medicine physicians working at 18 different centres across 13 countries (Canada, Czech Republic, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and the UK). The longest time available from the multiple-choice responses was selected by at least one respondent in all but four questions. Moreover, there were one or more potential outliers in 26 of the 39 questions. However, these cases were a minority among all the responses given and had little or no effect on the average results for the time estimates reported from the survey. Although medical physicists were chosen to be responsible for most of the tasks, the multidisciplinary nature of MRT dosimetry was shown.

Conclusions: Estimates of the time required for different tasks in MRT dosimetry and personnel responsible for those tasks are provided based on a survey among specialists in MRT. Variation in time estimates, which is relevant for a minority of the responses, would reflect the different experience and methods used at different centres. Medical physicists are chosen to be responsible for a majority of tasks, but the responsibility of other personnel categories in some tasks is also shown. Variations in some of the responses related to personnel would reflect different workflow and national or local preferences.

Keywords: Molecular radiotherapy, dosimetry, time estimates, personnel responsible, survey

Background

Molecular radiotherapy (MRT) is the selective delivery of radionuclides to target and destroy malignant cells, mainly by exposure to the emitted beta or alpha particles [1, 2]. In most cases, these radionuclides are labelled to carrier molecules, also called vectors, for which tumour cells show avidity [3–5]. There is a wide variety of radionuclides and vectors used to treat a diversity of diseases [6–9], and their number is increasing, favoured by intense research in the field of theranostics in nuclear medicine [10–12].

In other therapeutic techniques with ionising radiation, such as external beam radiotherapy (EBRT) or brachytherapy, the International Commission on Radiation Units and Measurements (ICRU) has standardised the prescription, recording and reporting of treatments [13–18]. Moreover, the International Atomic Energy Agency (IAEA) has released documents on the determination of absorbed dose in EBRT, calibration of sources in brachytherapy and commissioning and quality assurance of treatment-planning systems [19-21]. Thus, EBRT and brachytherapy treatments are carried out on the basis of accurate dosimetric characterisation of all equipment involved in planning and delivering the treatment. Currently, this is not the case in MRT, as shown in a survey performed by the former Internal Dosimetry Task Force (IDTF) [22] of the European Association of Nuclear Medicine (EANM). However, the European Directive 2013/59 Euratom [23] establishes the obligatory nature of treatment optimisation and verification in MRT. In order to address the implementation of the Directive, the EANM recently released a position paper [24] in which three levels of dosimetry are proposed. These levels include an activity-based prescription with patient-averaged dosimetry, an activity-based prescription with patient-specific dosimetry and, a dosimetry-based prescription and post-therapy dosimetry verification.

A report by the IDTF [3] addressed the potential and prospect of treatment planning for the main treatments of MRT. However, whilst several dosimetric approaches were included in the report, the resource implications were not thoroughly examined. Current practices of dosimetry for MRT were investigated in a topical report of the Institute of Physics and Engineering in Medicine (IPEM) [26], including the potential barriers in setting up a clinical dosimetry service. It was concluded that in the UK, most medical physics groups are well equipped to provide a simple form of dosimetry service, but in most cases refrain to perform dosimetry routinely by ‘lack of clinical evidence and practice’ and that more complex dosimetry will require additional staffing.

Previous documents [27-29] have addressed the subject of resourcing in nuclear medicine, including estimates of medical physics time, pertinent to dosimetry and radiation safety across different therapies, such as thyrotoxicosis, thyroid carcinoma and neuroendocrine tumours [28, 29]. However, those estimates were not specific for the particular dosimetry workflow that is specific to each therapeutic procedure. For instance, in the treatment of neuroblastoma with [^{131}I]I-mIBG, dosimetry may be performed for the whole-body dosimetry utilising portable radiation detectors or at the lesion level using image-based techniques. [30]. Moreover, as with EBRT and brachytherapy dosimetry [31-34], time has to be dedicated to initial protocol development and configuration of equipment (Figure 1). Additionally, several disciplines may be involved in the different tasks associated with the dosimetry workflow.

To better understand the potential resources being dedicated to the main tasks within a dosimetry workflow in MRT (Figure 1) and the personnel groups undertaking these tasks, a survey was conducted among different experts working in MRT dosimetry. The present document reports on the results of that survey.

Methods

The survey was prepared by the Dosimetry Committee of the EANM in the form of an electronic questionnaire and was distributed amongst experts working in MRT. Respondents to the survey were mostly members of the former IDTF or Dosimetry Committee of the EANM. Table I summarizes the structure of the survey and all included questions are shown in table A.I of Appendix I. An introductory page which contained instructions and explanation of the rationale for the survey was given to participants. The survey was divided into three main sections corresponding to the principal stages of MRT dosimetry (see Figure 1). Each section contained further introductory explanations. Where necessary each section of the questionnaire was split into further subsections relating to different procedures or dosimetry approaches.

The section dedicated to protocol development did not include any subsections as it was assumed a similar time was required for developing a dosimetry protocol irrespective of the therapeutic procedure. The section relating to initial set-up and preparation of equipment was divided into five subsections. Four of these sections addressed the main equipment used in MRT dosimetry, namely portable radiation detectors, gamma well counters and liquid scintillation counters, thyroid uptake probes and SPECT/CT or PET/CT scanners. The final subsection concerned data analysis of the equipment configuration. The section of the survey related to patient measurement and dosimetry calculations was also subdivided into five subsections. The first four subsections addressed the resources dedicated to activity measurement using the aforementioned equipment. The final subsection covered the resources for absorbed dose calculations using the activity measurements.

For the online survey, questions relating to time resources appeared as drop-down lists covering a wide range of available options (see Appendix I). Questions relating to responsible personnel were multiple-choice and included option for medical physicist, medical doctor, technologist, nurse, engineer and other. Participant responses were exported for analysis to a spreadsheet.

Table I. Sections and subsections appearing in the survey

1. Protocol development

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2. Initial set-up
    2.1. Portable radiation detector
    2.2. Gamma well counter and liquid scintillation counter
    2.3. Thyroid uptake probe
    2.4. SPECT/CT and PET/CT scanners
    2.5. Data analysis

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3. Patient dosimetry
    3.1. Whole body dosimetry with portable radiation detectors
    3.2. Blood dosimetry with gamma well counters and liquid scintillation counters
    3.3. Thyroid dosimetry in benign thyroid disease with thyroid uptake probes
    3.4. Image-based dosimetry with SPECT/CT and PET/CT scanners
    3.5. Absorbed dose determination

Results

The survey was completed by 19 medical physicists and two nuclear medicine physicians working at 18 different centres across 13 countries (Canada, Czech Republic, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and the UK). Not all participants responded to each question as in some cases a particular method of dosimetry may not have been undertaken at that centre. A detailed analysis of the responses to each question is presented in Appendix II. Results for time estimates were summarised as box whisker plots in which the box extends from the first to third inter quartile range about the median value. The whiskers correspond to the maximum and minimum values of all responses. The percentage of responses in which each personnel group was selected were summarized in bar diagrams, for which the following abbreviations are used: Phys.= medical physicist, M.D.= medical doctor, Tech.= technologist, Eng.= engineer. As questions relating to personnel allowed for more than one choice, the total percentage exceeded 100% in some cases, indicating more than one personnel group was responsible for that task. Using these data some specific examples for different MRT dosimetry tasks are provided giving estimates of the potential time dedicated to dosimetry and which personnel group or groups could be primarily responsible. Time estimates are given as median (1st quartile, 3rd quartile) and are summed for each step in the dosimetry process to give an indication of the total resource required to prepare and undertake a dosimetry study.

Whole-body dosimetry using a portable radiation detector in the treatment of neuroblastoma with [^{131}I]I-mIBG

In treatments of neuroblastoma with [^{131}I]I-mIBG, patients often spend several days in the treatment room for radiation-protection purposes [30]. Whole-body measurements can be used to track the activity clearance from the body so as to determine an appropriate time for discharge. In addition, these results can be used for dosimetry as a surrogate for bone marrow dosimetry and predicting haemotoxicity. Several measurements per day are performed, from which the whole-body activity at each time point is determined. A function is fitted to the time activity data and integrated, to obtain the time-integrated activity. The whole-body absorbed dose is calculated from this using an S-value scaled according to the patient body mass [30]. For 20 whole-body measurements a total required time of 2.5 hours is estimated to obtain these data. The responsibility of the measurements is shared mainly by medical physicists and technologists. A further 1.4 hour is required for analysis and interpretation of data (activity and absorbed dose determination), which is generally carried out by the medical physicist. Initial set-up of portable radiation detectors would need 2 h as results from the survey indicate, but it is not strictly necessary if a conversion factor from dose rate to activity is obtained from the first patient measurement [30]. Table II summarises the separate tasks, together with the time estimates and personnel responsible.

Table II. Summary of the tasks, time estimates and personnel responsible for determining the whole-body absorbed dose in treatments of neuroblastoma with [131I]I-mIBG with a portable radiation detector

Task	Time estimate (h)	Responsible
Whole-body measurements (20 measurements)	2.5 (0.8, 4.2)	Medical physicist /Technologist
Whole-body activity determination	0.9 (0.5, 1.0)	Medical physicist
Whole-body absorbed dose determination	0.5 (0.3, 0.7)	Medical physicist
TOTAL	**3.9**	

Treatment planning in treatments of metastatic differentiated thyroid cancer with [^{131}I]I-NaI

In treatments of metastatic differentiated thyroid cancer, treatment planning can be performed after administration of a tracer activity to determine the activity to be administered to reach a maximum tolerable red marrow absorbed dose of 2 Gy [35]. For this example, five blood extractions and five whole-body dose-rate measurements are assumed [36]. Table III summarises the tasks, together with the time estimates and personnel responsible, as indicated from the survey results. Blood extractions are generally carried out by a nurse or technologist and samples prepared by a medical physicist or technologist. For tasks related to whole-body, responsibilities are those of the previous example. Interpretation and processing of the results fell to the medical physicist. The whole process is expected to take about half a working day, but is often split over many days as the blood samples are taken over a 4 or 5 day period, so equates to less than 1 hour per day of physics time. These values are similar to that expected for a glomerular filtration rate service.

Table III. Summary of the tasks, time estimates and personnel responsible for determining the red marrow absorbed dose in treatments of metastatic differentiated thyroid cancer with 131I-NaI

Task	Time estimate (h)	Responsible
Blood extraction (5 samples)	0.6 (0.2, 1.0)	Nurse/Technologist
Blood samples preparation	0.4 (0.2, 0.4)	Medical physicist /Technologist
Blood samples measurement	0.4 (0.2, 0.7)	Medical physicist /Technologist

Blood activity concentration determination	0.4 (0.2, 0.7)	Medical physicist
Whole-body measurements (5 measurements)	0.6 (0.2, 1.0)	Medical physicist /Technologist
Whole-body activity determination	0.2 (0.1, 0.3)	Medical physicist
Red marrow absorbed dose determination	1.0 (0.6, 1.4)	Medical physicist
TOTAL	**3.6**	

Thyroid dosimetry with a thyroid uptake probe in the treatment of benign thyroid disease

In treatments of benign thyroid disease with [^{131}I]I-NaI, the activity to deliver the prescribed absorbed dose can be calculated by means of a pre-therapy dosimetry administering a tracer. Two measurements of the [^{131}I]I-NaI uptake in the thyroid can be performed and afterwards, the [^{131}I]I-NaI uptake must be determined at each time point. With those values and the thyroid mass which is usually obtained from ultrasound imaging, the thyroid absorbed dose delivered by the tracer is calculated and then the activity to administer for the therapy [37]. A previous calibration of the thyroid uptake probe would take 0.7 h according to the survey. The thyroid uptake measurements would take 0.4 h and the data analysis to determine the activity and the absorbed dose to the thyroid 0.3 h. Responsibility for uptake measurements mainly fell to medical physicists and technologists and calculations of activity and absorbed dose to medical physicists. Table IV summarises the separate tasks, together with the time estimates and personnel responsible.

Table IV. Summary of the tasks, time estimates and personnel responsible for determining the activity to administer in treatments of benign thyroid disease with [131I]I-NaI with a thyroid uptake probe

Task	**Time estimate (h)**	**Responsible**
Thyroid uptake measurements (2 measurements)	0.4 (0.2, 0.5)	Medical physicist /Technologist
Thyroid activity determination	0.1 (0.2, 0.4)	Medical physicist
Thyroid absorbed dose determination	0.2 (0.3, 0.5)	Medical physicist
TOTAL	**0.7**	

Image-based dosimetry in treatments of neuroendocrine tumours with [^{177}Lu]Lu-DOTA-TATE

To perform the preparatory imaging tests on a SPECT/CT scanner prior to image-based dosimetry, a variety of phantoms can be prepared [38-40]. In this example, a cylindrical water-filled cylindrical phantom, used to determine the calibration factor, and a phantom with fillable inserts, used to determine the recovery curve (e.g. the NEMA IEC Body phantom set) are considered. Images of both phantoms are acquired, processed, and analysed with image processing software. Lastly, the gathered data are analysed and the calibration factor and recovery coefficients determined. From the results of the survey this task would generally be performed by the medical physicist and require a full working day to obtain and analyse the required data. Table V summarises the separate tasks undertaken, together with the estimated time required. It should be noted that this procedure is generally only completed once, prior to initiating a dosimetry service, or infrequently (e.g. annually) as part of a regular quality assurance programme.

Table V. Summary of the tasks, time estimates and personnel responsible for the set-up of a SPECT/CT scanner for image-based dosimetry

Task	**Time estimate (h)**	**Responsible**
Phantom preparation	1.5 (1.3, 2.6)	Medical physicist
Image acquisition	1.8 (1.2, 3.6)	Medical physicist
Image processing	1.4 (0.5, 2.3)	Medical physicist
Image analysis	2.0 (1.2, 3.0)	Medical physicist
Data analysis	2.0 (1.3, 3.5)	Medical physicist
TOTAL	**8.7**	

Two different approaches are considered for patient dosimetry measurement. In the first approach, image-based kidney dosimetry is performed using a single SPECT/CT acquisition

[41] following treatment with [^{177}Lu]Lu-DOTA-TATE. Acquired data are reconstructed, processed and the activity and volume (or the activity concentration) of the kidney determined. Time-integrated activities are calculated, and subsequently the absorbed doses. In this example, it is assumed that a spreadsheet is used for calculation of absorbed dose, rather than using a dedicated dosimetry software package. Table VI summarises the tasks, together with the time and personnel responsible. Results indicate that a dosimetry study can be completed in just over 2 hours, including time dedicated to imaging the patient and for the manual calculations of the absorbed dose. Responsibility was generally that of the technologist for scanning. For image processing responsibility is shared between medical physicists and technologists, and for activity and volume determination, which implies organ outlining, between medical physicists and medical doctors. Lastly medical physicists were considered as responsible for absorbed dose calculations.

Table VI. Summary of the tasks, time estimates and personnel responsible for performing image-based dosimetry of one kidney in a treatment of neuroendocrine tumours with [177Lu]Lu-DOTA-TATE

Task	**Time estimate (h)**	**Responsible**
SPECT/CT image acquisition (1 image)	0.8 (0.5, 0.8)	Technologist
SPECT/CT image processing (1 image)	0.1 (0.1, 0.3)	Medical physicist /Technologist
Activity and volume determination	0.3 (0.1, 0.5)	Medical physicist /Medical doctor
Absorbed dose determination	1.0 (0.4, 1.0)	Medical physicist
TOTAL	**2.2**	

The second approach considers a more complex scenario whereby the doses of two lesions and one kidney are of interest. Three SPECT/CT acquisitions are modelled in this scenario. The methodology is the same as described in the case of the kidney dosimetry summarised in table VI. Due to the additional scanning and image processing, technologist time increases accordingly. More physics resources are also required as the absorbed dose calculation is more complex and organ and lesion delineation is more time consuming, which also would increase the time of medical doctor. Whilst the results indicate that a full working day is necessary to perform these calculations, it should be noted that this dosimetry schedule is protracted over a full week so amounts to just over one hour per day per patient. Table VII summarises the tasks, together with the time and personnel responsible, as obtained from the survey.

Table VII. Summary of the tasks, time estimates and personnel responsible for performing image-based dosimetry of two lesions and of one kidney in a treatment of neuroendocrine tumours with [^{177}Lu]Lu-DOTA-TATE.

Task	**Time estimate (h)**	**Responsible**
SPECT/CT image acquisition (3 images)	2.3 (1.5, 2.3)	Technologist
SPECT/CT image processing (3 images)	0.4 (0.4, 0.8)	Medical physicist /Technologist
Activity and volume determination	2.3 (1.3, 4.2)	Medical physicist /Medical doctor
Absorbed dose determination	3.0 (1.2, 3.0)	Medical physicist
TOTAL	**8.0**	

Discussion

Analysis of the results

In this document, the results of a survey (taken by 21 MRT dosimetry experts) relating to time estimates and personnel responsible for dosimetry have been reported. The diversity of participant centres from 13 different countries is likely to encompass differences in the protocols used, the equipment and resources available, the experience of the personnel, and the software used. This has resulted in some variation in the reported results.

A large variation was observed in the answers to the questions regarding dead time characterization of SPECT/CT and PET/CT scanners, which may be explained by the differences in the methods used for dead time assessment, which was not addressed in the survey. It is noteworthy that the maximum time in the range shown in Table A.I in Appendix I was chosen by at least one respondent in all but four questions, and that there were one or more potential outliers in 26 of the 39 questions corresponding to a higher time estimate. However, those cases are a minority among all the responses given and have little or no effect on the first quartile, median and third quartile values of the time estimates reported from the survey.

In 16 of the 24 questions regarding personnel, the most frequent response was also more than all other responses put together (Table VIII), indicating clear identification of the responsible person for that task. In 15 of those 16 responses responsibility was reported as that of the medical physicists. In the remaining eight questions, the majority of personnel were indicated across two staff groups. The medical physicists were one of those groups in seven cases (Table IX). The only tasks where the medical physicist was not indicated as primarily or jointly responsible were in the extraction of blood samples and the acquisition of patient images.

Despite the clear indication that dosimetry is primarily undertaken by the medical physicists, the multidisciplinary requirements of dosimetry are still highlighted in the survey, with responsibilities indicated in other staff groups. Inter-centre variability, which may reflect the different local practice and legal regulations among countries, is also reflected. Tasks for which at least four personnel groups were indicated are marked with an asterisk in Tables VIII and IX.

Table VIII. Personnel group responsibilities where the most frequent response is more than all the other responses put together. Tasks for which at least four personnel groups were chosen are marked with an asterisk.

Stage		Task	Personnel responsible
Set-up	Portable radiation detector	Phantom preparation *	Medical physicist
	Portable radiation detector	Phantom measurement	Medical physicist
	Thyroid uptake probe	Phantom preparation *	Medical physicist
	Thyroid uptake probe	Phantom measurement	Medical physicist
	SPECT/CT scanner	Phantom preparation *	Medical physicist
	SPECT/CT scanner	Image acquisition	Medical physicist

	SPECT/CT scanner	Image processing	Medical physicist
	SPECT/CT scanner	Image analysis	Medical physicist
	All equipment	Data analysis	Medical physicist
Patient dosimetry	Whole-body dosimetry	Activity determination	Medical physicist
	Blood dosimetry	Activity determination *	Medical physicist
	Thyroid dosimetry	Activity determination	Medical physicist
	Image-based dosimetry	Image acquisition *	Technologist
	Image-based dosimetry	Image processing	Medical physicist
	Image-based dosimetry	Activity and volume determination	Medical physicist
	All types of dosimetry	Absorbed dose determination	Medical physicist

Table IX. Personnel group responsibilities where the two most frequent responses (separated by a / mark) have to be added together to be more than all the other responses put together. Tasks for which at least four personnel groups were chosen are marked with an asterisk.

Stage		Task	Personnel responsible
Protocol development		Protocol development *	Medical physicist /Medical doctor
Set-up	Gamma well counter	Phantom preparation	Medical physicist /Technologist
	Gamma well counter	Phantom measurement	Medical physicist /Technologist
Patient dosimetry	Whole-body dosimetry	Patient measurement *	Medical physicist /Technologist
	Blood dosimetry	Blood extraction *	Nurse / Technologist
	Blood dosimetry	Sample preparation *	Medical physicist /Technologist
	Blood dosimetry	Sample measurement *	Medical physicist /Technologist
	Thyroid dosimetry	Patient measurement	Medical physicist /Technologist

Resource implications of implementation of MRT dosimetry

Although the performance of MRT dosimetry entails an increase in resources, most of the equipment required may already exist in the facility for diagnostic and radiation protection purposes, so the additional resources required are mainly personnel time and use of the equipment. Protocols should be developed in sufficient detail, for which EANM guidelines and MIRD pamphlets [30, 36–40, 42, 43] may provide useful guidance. Moreover, set-up and regular quality control [44, 45] of the equipment have to be carried out. Regarding the use of the equipment, some of the images acquired for dosimetry may also be used for diagnostics, and some dose-rate measurements may also be used with radiation protection aims, thus reducing the impact of the increase in resources. A recent IPEM report [26] concluded that most UK centres were generally well equipped to perform MRT dosimetry, but that there was a staff shortage for the increase in tasks that MRT dosimetry entails.

There are some documents that have reported on times needed to perform dosimetry [28, 29]. In those documents, time of medical physicists for an outpatient therapy of thyrotoxicosis with [^{131}I]I-NaI, an in-patient therapy of differentiated thyroid carcinoma with [^{131}I]I-NaI and for a complex therapy, such as therapies with [^{131}I]I-mIBG, ^{177}Lu or ^{90}Y, are reported. However, those documents do not take into account the differences in time needed for image-based dosimetry that can appear for different scenarios, as shown in the example given for treatments of neuroendocrine tumours with [^{177}Lu]Lu-DOTA-TATE. The example showed how when two lesions and kidneys imaged three times are considered , the time needed to perform dosimetry is notably higher than when only kidneys imaged once are considered (8.0 h vs 2.2 h). Therefore, data from those documents are not directly comparable with the results from the survey. The documents of the IAEA [28] and the European Federation of Organisations for Medical Physics (EFOMP) [29] report, respectively, working times of 9 h and 12 h of medical physicist for a dosimetry of [^{177}Lu]Lu-DOTA-TATE. Those values are apparently higher than those reported from the survey, but they could be regarded as the maximum time that a dosimetry can take for the case of maximum complexity. For instance, for the case of [^{177}Lu]Lu-DOTA-TATE when in addition to image-based dosimetry including kidneys and a high number of lesions, whole-body and blood dosimetry are also performed. As the current document is more specifically concerned with MRT dosimetry, it gives a detailed breakdown of the time estimates and personnel responsible for dosimetry, and thus allows for more detailed calculations of the time needed to perform dosimetry and determines the personnel responsible for the tasks to be performed.

Times needed for clinical dosimetry may vary depending on the experience of the personnel of the specific centre, and may increase if training is required, or if procedures with novel treatments or radionuclides are introduced. The development and implementation of dosimetry-oriented software [46-54] may reduce the time required for dosimetry, but only with a wider use of such tools could the potential time saving be estimated. Additionally, in short term, the time dedicated to organ delineation is expected to decrease significantly thanks to automatic delineation using Artificial Intelligence, as preliminary results have shown [55]. To fully understand the practicality of the resource requirement for MRT dosimetry, it would be of interest to know the current available resourcing across nuclear medicine and medical physics departments in different countries, for which a survey is warranted, as has been performed for EBRT [56, 57]. Results of another survey [58] stated that reimbursement is a key factor in defining which resources are made available to ensure quality, efficiency, availability and access to specific healthcare interventions, among which dosimetry-guided MRT treatments could be included. Thus, the results of the present document could be used to support applications for reimbursement.

Conclusions

Estimates of the median time required for different tasks in clinical MRT dosimetry and personnel responsible for those tasks are provided based on a survey among specialists in MRT dosimetry. The survey indicated some variation in time estimates, reflecting the different experience and methods used at different centres. There was also a variation in the personnel category responsible for the tasks, reflecting different workflow and national or local preferences. While medical physicists are responsible for most tasks in dosimetry, the multidisciplinary nature of MRT dosimetry is highlighted.

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Statements and Declarations

Funding

NHS funding was provided to the NIHR Biomedical Research Centre at The Royal Marsden and the ICR

Competing Interests

All authors report no conflicts of Interest

Ethics Approval

This manuscript does not contain proprietary research involving either humans or animals

Consent to Participate

This manuscript does not contain proprietary human data; accordingly an informed consent is not applicable.

Liability

This document summarizes the views of the co-authoring EANM Committee members. It reflects recommendations for which the EANM cannot be held responsible. The recommendations should be taken into the context of good practice of nuclear medicine and do not substitute for national and international legal or regulatory provisions.

Figures

Figure 1. Dosimetry workflow in MRT.