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Radiation therapy staffing model 2014

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Abstract

Introduction: In 2001, the Radiation Therapy Advisory Panel (RTAP) of the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) (formerly known as Australian Institute of Radiography) published a model for radiation therapist staffing in Australian radiation oncology departments. Between 2012–2013, the model was reviewed to ensure it reflected current radiation therapy practice, technology, and to facilitate forward planning of the radiation therapy workforce. **Method:** Twenty-four sites from all states participated and provided data on megavoltage simulation, planning and treatment delivery. For simulation and planning activity, the length of time to complete was collected against relevant Medicare Benefits Schedule (MBS) items. For treatment delivery, time to complete activities was collected against a common set of activities. Modelling assumptions are clearly identified in the methodology. **Results:** A new model was developed retaining the essential model parameter of full-time equivalent (FTE) radiation therapists (RTs) per linear accelerator operating hour as in the 2001 model but based on contemporary practice and data. The model also includes significant refinements that improve the model's overall utility and flexibility for both workforce planning purposes and for individual services to use the model according to their own organisational needs and service delivery profiles. **Conclusion:** The ASMIRT believes that the 2014 RT staffing model provides the utility and flexibility for radiation oncology services to best plan RT staffing establishments according to their needs and reflecting the diversity between services and within the sector. It should also provide a robust and valid basis for governments and service planners to use as a guide in workforce planning into the future.

Introduction

In 2001, the Radiation Therapy Advisory Panel (RTAP) of the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) (formerly known as Australian Institute of Radiography) published a model for radiation therapist staffing in Australian radiation oncology departments.[1] A driver of the 2001 model was the significant shortage of radiation therapists (RTs) at that time and the implications for cancer patient care identified in the National Strategic Plan for Radiation Oncology published in 2000, which subsequently gave rise to the influential Baume Report published in 2002.[2,3] Implicit in the problems identified was absence of a useful model for workforce planning.

The 2001 staffing model did not include staffing recommendations for intensity-modulated radiation therapy (IMRT) as this was a relatively new technique. By 2010, over 70% of Australian radiation oncology services had adopted IMRT and by 2015, the number of patients treated with IMRT was over 30%.[4,5] IMRT techniques are more resource intensive as they require significantly longer preparation time and therefore comprise a significant component of the workload.[4]

Radiation oncology services have changed in complexity since 2001. Radiation oncology now uses some of the most advanced information technology infrastructure in the health care system to support its data and imaging needs as well as intensity-modulated and image-guided treatment delivery, and stereotactic body radiation therapy.[6] A consequence of rapidly changing technology is that diversity between radiation oncology services in terms of their technology capabilities is greater than ever before. For instance, external beam treatment may now be delivered by conventional linear accelerators, tomotherapy units, gamma/cobalt units, and robotic units, often incorporating sophisticated image guidance technology. Accordingly, a radiation therapy staffing model that provides flexibility and can be customised to the needs of particular services and where they are on the technology spectrum is clearly needed.[7] A 'one size fits all' model is no longer sufficient to meet the needs of effective workforce planning. However, the revised model should continue to be based primarily upon the operating hours of megavoltage external beam treatment units as this remains the core business of all radiation oncology centres.[1,8]

Hence, in 2012, the ASMIRT considered it necessary that the 2001 staffing model be reviewed and refreshed to reflect current radiation oncology practice, technology and service organisation in Australia.

Methods

Quantitative activity timing data for simulation, planning and treatment delivery was collected from a representative group of Australian radiation oncology services for 1 week between March and July 2013. Nineteen organisations participated in the data collection phase, with data collected at 24 sites across six states, including public and private, metropolitan and regional, single and multi-site services. As this was a quality improvement project, this study was exempt from research ethics approval.

Data collection tools for megavoltage simulation and planning were developed using Medicare Benefits Schedule (MBS) item numbers as the basis for activity timing data as it was considered this would provide a common way of stratifying workload and case mix. MBS item numbers were not considered to be useful in describing workload and case mix for megavoltage treatment delivery. For treatment delivery, it was decided to use a generic list of common activities and treatment tasks developed with input from participating services.

Each participating site was asked to complete a data collection tool for each patient simulated and planned during a 1 week period. The data collected included the MBS item number and the time taken to perform each activity. The treatment data collected over the week included all activities performed (i.e. assessment of verification images) plus hours of treatment delivery.

External consultants with knowledge of the radiation oncology sector (Amica Consulting) were engaged to clean, validate and analyse the data collected and to provide a report that would contain the data to underpin the model.[9] The external consultants visited six of the participating sites (one in each state and included a rural, large and small site) to independently validate the data using extracts from the information management systems used at each site. While the ASMIRT and RTAP managed the data collection process, the strategy of independent validation of the data enabled the ASMIRT to remain at 'arm's length' from the key data elements that would be used in the final modelling process.

A thorough literature review was conducted so that the many activities other than direct patient care that are increasingly important in any modern, quality focused radiation oncology service could be included in the recommended staffing numbers. These activities include education and training, research and development, quality and safety, and information management and may be considered common to most services. The recommended numbers are not based on quantitative data as this was outside the funding scope of the project. The rationale for the non-direct patient care staffing numbers in the model is described in the discussion.

The model also seeks to account for some economy of scale efficiencies reflecting the range of service sizes and organisational structures that exists across the radiation oncology sector.

To establish a standardised base for modelling, it was essential that the assumptions made and planning parameters used be defined. These are as follows:

1 The model deals with qualified radiation therapists only and does not recognise staff in supervised practice programs (SPPs). It continues to be the ASMIRT's position that new graduates undertaking SPPs be considered supernumerary to RT staffing establishments.
2 Based on an 8 h day, there are approximately 215 working days/1720 h per RT per annum, assuming:
   - An 8 h day and 38 h week continues to be a useful benchmark of RT working days/weeks
   - Two hundred and fifteen working days per 1.0 full time equivalent (FTE) is based upon approximately 250 business days per annum less all standard leave allocations which are assumed to be: 20 days annual leave, 10 days sick leave and 5 days other leave including conference and professional development leave, which together comprise 280 h and a 16% leave overhead (280/1720), with acknowledgment this may vary between jurisdictions, award conditions and public and private practice.
3 To estimate planning workload per linac, 420 courses per linac per annum has been used.
4 One RT is required to be available to operate a simulator or CT/simulator and two RTs available to treat on a linac for the entire 8 h operating day (warm up and quality assurance time for machines has been included in the modelling).
5 Services are generally very aware of the operating hours needed to accommodate demand and able to profile their planning workloads in terms of relevant MBS item numbers as a de facto indicator of case mix and complexity.

Lastly, the revised model does not seek to quantitatively model staffing numbers for kilovoltage or brachytherapy services as these may not be common to all services. It is acknowledged that these are reasonably common and suggested staffing requirements are described.

Results

In their report, Amica Consulting state that the validation process demonstrated that the survey was well conducted at the six sites chosen for on-site validation. Nevertheless, some adjustments were required to data from some sites. Aggregated results accounted for approximately 93% of rostered staff time, implying that generally there was very little unaccounted for time at the validation sites. The adjustments made to data at validation sites were also of sufficient general applicability such that the conclusions drawn from the validation process could be extended to the non-validated sites. This resulted in Amica defining a 'recommended scenario' upon which the core modelling is based.[9]

Simulation

There were 648 'raw' simulation records provided and when data were cleaned, 624 valid records were available for analysis. Amica concluded that the simulation survey was well conducted with a high level of correlation between validated and non-validated service's data, with 601 records used in the final analysis.[9] Table 1 describes simulation workload by MBS code, the mean simulation time/case (this includes 30 min for the CT/Simulation operating RT plus the RT planner's time), percentage and number of cases per annum to arrive at a total figure of RT time per MBS case type per annum. This is then divided by the assumed numbers of RT hours available per annum per RT FTE (1720) to derive the FTE required to simulate 420 cases per annum. Descriptors for the simulation and planning MBS items are included in Appendix S1.

Table 1. Simulation.

MBS code	Mean time/case (min)	% of cases per annum	No. of cases per annum	Total time (h)
15500	97	15.8	66	107.3
15503	107	3.3	14	24.7
15506	116	13.6	57	110.4
15550	105	62.6	263	460.1
15553	137	4.7	20	45.1
Totals	[1]Mean = 106 min	100	420	747.6 Required FTE = 0.43

MBS, medicare benefits schedule; FTE, full-time equivalent.
[1]Includes 30 min CT/simulator operator time.

Planning

There were 614 'raw' planning records provided from participating services and centres and when data were cleaned, 624 valid records were available for analysis (40 additional valid records were added as a result of the site validation visits). The mean planning time after validation adjustments was 358 min, (range 139 min for MBS code 15518 to 526 min for code 15562), with 69% of records in the three highest complexity codes.[9]

Amica concluded that there were a number of issues with this part of the survey, the most significant being a consistent underestimate of planning time most likely due to the stop start nature of planning activities and tasks which may span multiple cases concurrently making accurate recording a relatively difficult task.[9] Accordingly, adjustments were made to four of the six validation sites data resulting in adjustments of data for all participating services.[9] The baseline workload profile for planning is detailed in Table 2.

Table 2. Planning.

MBS code	Avg. time/case (min)	% of cases per annum	No. of cases per annum	Total time (h)
15518	139	8.9	37	86.6
15521	281	2.0	8	39.3
15524	268	14.7	62	275.8
15527	144	3.0	13	30.2
15530	267	0.5	2	9.4
15533	428	1.8	8	53.9
15556	273	14.9	63	284.7
15559	332	14.0	59	325.4
15562	526	40.2	169	1480.2
Totals	Mean = 358	100	420	2585.5 Required FTE = 1.50

MBS, medicare benefits schedule; FTE, full-time equivalent.

Treatment

Unlike simulation and planning, the baseline workload profile for treatment cannot easily be profiled in terms of MBS item numbers as these do not indicate complexity.[10] Instead, linac staffing has been defined in terms of activities undertaken in a typical 8 h operating day.

There were 189 ‘raw’ treatment records provided from 21 centres and when data were cleaned, 91 valid records were available for analysis. Amica concluded that there were also a number of issues with the treatment survey mainly related to the survey format itself.[9] No adjustment was required, however, as this only related to data from two of the 21 participating centres and was considered to have a low impact on data quality overall.[9] The baseline workload profile for treatment is detailed in Table 3.

Table 3. Treatment.

Activity/task	Average time (min)
Linac warm up	45
Managing patient bookings	37
Team organisation	21
New case checks	56
New patient preparation	35
Course completion checks	26
Chart review	62
Image review & management	57
Logging & responding linac faults	19
Education & training	128
Actioning radiation oncologist review notes	26
Technical development	22
Staff familiarisation new techniques	22
Cover for in-services & meetings	40
Other	86
Treatment (2 × RTs 8 h each)	960 Required FTE = 3.42

FTE, full-time equivalent.

Education and training, management, research and development, quality and safety, and information systems management

The FTE numbers used in the model for education and training, management, information systems management, research and development and quality and safety are recommended numbers based on a literature review. They should be considered in the context of each service’s organisational model and operating environment. Individual services may use their own numbers in the model to derive an adjusted, customised FTE per linac operating hour reflective of their service’s particular needs. The rationale for these is described in the discussion.

The revised model

Table 4 demonstrates the essential workings of the basic staffing model. The figures in brackets indicate the FTE requirement for a satellite centre (i.e. a centre with links to a main centre in a different location).

Examples of how this model would apply for an average size department of three linacs operating a standard 8 h day over all machines and a large department of six linacs with a satellite centre with two linacs and all machines operating 9 h per day are as follows:

Table 4. Basic staffing model.

	Number of linacs					
Staffing functions	1	2	3	4	5	6
Management (add 1 per satellite)	1	1.5	2	2	2	2 (3)
Head of sections (add 2 per satellite)	1	2	2	2	2	2 (4)
Information systems management	0.5	1	1	2	2	2
Education & training	0.75	1.5	2.25	3	3.75	4.5
Research and development	0.5	1	1.5	2	2	2
Quality and safety	0.5	0.5	1	1	2	2
Simulation	0.43	0.9	1.3	1.7	2.2	2.6
Planning	1.5	3.0	4.5	6.0	7.5	9.0
Treatment	3.42	6.8	10.3	13.7	17.1	20.5
Base FTE	9.6	18.2	25.8	33.4	40.5	46.6
FTE with leave relief	11.14	21.11	29.93	38.74	46.98	54.06
RTs per linac operating hour	1.39	1.32	1.25	1.21	1.17	1.13 (1.20)

FTE, full-time equivalent.

- 3 linac department operating 8 h per day.

  Base RT staffing requirement $3 \times 8 \times 1.25 = 30$ FTE

- 6 linac department plus satellite with 2 linacs all operating 9 h per day (see numbers in brackets in column for 6 linacs in the table above).

Base RT staffing requirement $8 \times 9 \times 1.20 = 86.4$ FTE

Discussion

The ASMIRT Professional Practice Standards identify the need for adequate staffing levels in the workplace to not only reduce fatigue and stress that can lead to errors but also to ensure that the standard of patient care is maintained.[11] The Australian Tripartite Standards also recommend that workforce profiles include consideration of both direct and non-direct patient care activities and workloads for all radiation oncology staff (i.e. administration, teaching and education, continuing education, research and development, quality assurance and audit).[12] As a result, all staff rosters and schedules should incorporate time for non-direct patient care activities applicable to the facility's service delivery profile and evidence of this is required to demonstrate compliance with this standard.[12] The ASMIRT and Medical Radiation Practice Board of Australia (MRPBA) further support RT involvement in non-direct patient care activities and identify the importance of radiation therapists maintaining knowledge, skills and behaviour through professional development activities which include work-based learning, research and publication as integral to the professional responsibilities.[11,13,14]

It is important to note that the FTE recommended in this paper for non-direct patient care pertains to actual position numbers for Management and Head of Sections only. For education and training, research and development, quality and safety and information systems management, the FTE is indicative of the workload only. The recommended FTE for satellite centres is based on current national practice. They are considered by RTAP to be reasonable base numbers for planning purposes and individual services could, in using the model, apply their own numbers for these activities according to their organisational circumstances.

Education and training

Education and training staffing is a difficult area to model quantitatively. Resources must be considered in terms of both undergraduate students and graduates in professional practice training and qualified radiation therapy staff. Many factors, including an increasing emphasis on effective clinical learning environments, may affect education and training resources.[15] The Allen Consulting Group report projects that university intakes of RT trainees will need to increase by 7% a year if RT shortages are to be avoided in 2017 and 2022.[6] This will place increased demands on services to provide placements for clinical training of students and new graduates. Further, services may deal with more than one university requiring increased liaison and administration time. Similarly, the introduction of radiation therapy post graduate entry level programs such that student education and training now spans the entire calendar year whereas previously it spanned only the tertiary academic year also increases this workload. In addition, the need to ensure in-house educational and training support of qualified staff must be acknowledged given rapid technological change.[12,16]

Radiation oncology applications, technologies and methodologies continue to expand and develop, and continuing education is vital to ensure incorporation of new knowledge into clinical practice.[11–13,16] Radiation oncology is a technically demanding field which is dependent on well-trained and highly skilled members of the radiation oncology team.[11,14,16] It is crucial that all members of the team maintain the proper credentials, skills and training levels satisfying clinical competencies annually.[11,14,16] In some cases (e.g. radiation therapists moving between different kinds of treatment machines), additional training or refresher training in the use of specific devices may be necessary more often.[16] This is particularly relevant in planning where it has been identified that appropriate training is essential for patient safety.[13,17] In 2006, at the Beatson Oncology Centre in Scotland, a patient was overdosed with radiation by 58% which resulted in burns to her head and neck. Factors impacting that incident included inadequate training and supervision of the planner as well as the plan check not being independent.[17] It is important in radiation oncology to learn from other incidents and be mindful of the recommendations to ensure safety of practice.[12] Recommendations from a report on the Beatson incident include maintenance of training records for all staff so work can be allocated appropriately, checking of plans to be totally independent and direct supervision of trainees in planning is essential.[17] Due to variations in treatment planning systems, local methods and practices, individual radiation oncologist preferences, and changes in techniques, the level of training and supervision required in planning for qualified radiation therapists is significant.

As a result, it is proposed that 0.75 FTE be recommended in educational and training support of each linac planning/treatment unit, where a unit is defined as the RTs required to support the planning and treatment of patients for one linac in addition to any learners assigned to that unit. For example, a four linac service would allocate 3.0 FTE at a minimum to education and training. This ratio should complement the approximate 2 h per day captured in treatment activity timing relating to education and training, however, services would be able to vary this number in the model according to their own circumstances.

Management

Radiation therapists are typically the single largest staff group in a radiation oncology service and require an adequate management structure. Performance management systems, which are the remit of managers, are an essential part of radiation oncology services as dictated by the Tripartite Standards and ASMIRT professional practice standards.[11,12] RT managers also typically take on extended roles beyond their professional training reflecting post graduate qualifications in business and management that many managers possess these days. While high level management roles may not necessarily need to be backfilled in an RT manager's absence, many of their day to day operational roles do need to be delegated without causing undue impact on clinical staffing needs and direct clinical care. Accordingly, an adequate management structure is vital not only for these reasons but also to ensure a career structure is in place that enhances recruitment and retention within the profession and ensures capacity for succession planning.

Research and development

Involvement in research and development (R&D) may vary considerably between services but the 2014 model assumes some level of R&D involvement.[11,14] Accordingly, the MRPBA and ASMIRT require all RTs to engage in evidence-based practice and seek continuous improvement in service quality.[11,14] All services will be involved at times in implementing new techniques and technologies if not formal clinical trials and research. Factors that may dictate a service's need to allocate further staffing to R&D include: the number of clinical trials a service is involved with at any given time; RT involvement with recruitment of patients to clinical trials; the quality assurance workload associated with clinical trials with a radiotherapy arm; and RT involvement in the investigation and implementation of new technologies.

Quality and safety

The relationship between adequate staffing levels and patient safety in radiation oncology is well established.[11,12,14,16,17] In a 2008 publication on radiotherapy risk, the World Health Organization lists nine factors that contribute to risk reduction in radiation therapy.[18] Adequate staffing is one of the listed factors, however, other listed factors such as staff competency and assessment (education and training), and audit and incident reporting (quality) are also related to staffing and further reinforce the relationship between staffing levels and quality and safety of care.[12,16,17,19] Dedicated time for safety initiatives such as patient handling, CPR and emergency procedures training, incident reporting, near miss discussion, documentation of policies and procedures is also recommended for radiation oncology staff.[11,16] The Tripartite Standards require evidence of documented policies and procedures to demonstrate compliance.[12] A major recommendation from the Beatson incident is for planning procedures to be documented which is also supported by the ASMIRT who identify the documentation of clinical procedures as part of professional practice.[11,17] This recommendation applies to simulation and treatment as well. Maintenance of such documentation for radiation therapists is an ongoing part of their workload.

Quality improvement is another significant component of the RT scope of practice and includes the regular review of practices and the contribution towards risk assessment, audit, incident reporting and analysis.[11] Compliance with the National Safety and Quality Health Service Standards and the Tripartite Radiation Oncology Practice Standards should be taken into account when factoring in FTE for quality activities.[11,15] The modelling incorporates and attempts to address these factors.

Information systems management

There is an increased reliance on the electronic medical record (EMR) in radiation oncology services.[14,16] Modern radiation therapy involves the use of a computerised treatment management system which manages treatment delivery and all treatment preparation and planning steps involved before treatment. These systems evolved from record and verify systems which were used to check manually set treatment parameters on 'analogue' treatment machines, to now involve an information system platform which includes:

- patient demographics databases,
- planning and treatment delivery data,
- applications to create/modify/edit and manage the data,
- procedural and workflow tools,
- and a treatment delivery system that directly manages the flow of activities during each fraction of a patients' treatment.[16]

This system communicates with departmental networks, hospital EMR, other ancillary treatment setup, verification, dosimetry and scheduling systems. The complexity of these systems requires considerable administration and management.[6] RT Managers require the support of trained system administrators and because of the increasing integration of clinical information, treatment planning, treatment delivery and imaging system, the need for at least one or more system administrators/managers to be RT trained is essential.

Stereotactic radiosurgery/radiation therapy, total body irradiation, paediatrics

The model does not describe FTE for specialist techniques such as stereotactic radiosurgery/radiation therapy (SRS/T), total body irradiation or paediatric treatments. Centres that perform these procedures should adopt the methodology the authors used to calculate FTE for treatment delivery and planning.

Conclusion

The ASMIRT believes that the 2014 RT staffing model is realistic, not prescriptive and provides the flexibility for radiation oncology services to best design RT staffing establishments according to their particular needs and reflecting the diverse needs of the sector. It should also provide a robust and valid basis for governments and service planners to use as a guide in workforce planning into the future.

It is recommended that the model be revised and refreshed at least every 5 years to ensure that it remains useful and relevant to all stakeholders. Given the pace of change since 2013 when the model data were collected, there could be valid argument made for revision of the model now.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Medicare benefits schedule item descriptors.
Appendix S2. RT Staffing Model 2014 - working version.