RESEARCH COMMUNICATION

Projecting the Radiation Oncology Workforce in Australia

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Abstract

Research on radiation oncologists has indicated that there is a shortage in supply of specialist workers in this field internationally, and also within Australia. However, there are no current estimates as to what the future Australian radiotherapy workforce will look like. This paper aims to review the current status and capacity of the three main disciplines that make up the radiation oncology workforce in Australia and project the workforce supply and demand for 2014 and 2019. Using data on the workforce from a survey of all radiotherapy facilities operating in Australia in 2008 a workforce model was constructed. This study found that there will be a future shortfall of radiation oncologists, radiation therapists and radiation oncology medical physicists working in radiation oncology treatment. By 2014 there will be 109 fewer radiation oncologists than what will be demanded, and by 2019 this figure will increase to a shortfall of 155 radiation oncologists. There was a projected shortfall of 612 radiation therapists by 2014, with this figure slightly decreasing to a shortfall of 593 radiation therapists in 2019. In 2014, there was projected to be a deficit of 104 radiation oncology medical physicists with a persisting shortfall of 78 in 2019. This future projected shortage highlights the need for radiation oncology workforce planning.

Keywords: Radiation oncology - workforce - planning - Australia

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Introduction

Radiotherapy is an important component of cancer treatment. Research shows that over 52% of cancer patients stand to benefit from the use of radiotherapy at some time during their disease trajectory (Delaney et al., 2005), either as part of curative treatment or for palliation of advanced disease. Radiation oncology services are provided through both public and private sectors in Australia and all States/Territories have radiation oncology treatment facilities. However, current utilisation of treatment is lower than the recommended rates (Allied Health Professional Workforce Planning Group, 2003) and it has been suggested that this may be in part attributed to a lack of staff (Baume, 2002).

There has been an increasing focus upon the management of health workforce for the optimal delivery of services both now and into the future (Goldacre 1998; Australian Medical Workforce Advisory Committee 2000; Duckett 2000; Borland 2002). This has been brought upon by the need for greater efficiency within health systems as both finances for health become stretched and as the health workforce in general ages and large proportions of the workforce in some professions enter retirement (Australian Government 2004; Productivity Commission, 2005).

International research on radiation oncologists has indicated that there is a shortage in supply of specialist workers in this field (The Royal College of Radiologists 2005; National Radiotherapy Advisory Group, 2007). Within Australia it has also been suggested that there is a current, and will likely be a future, shortage of staff in the radiotherapy field (Baume, 2002). However, there are no current estimates as to what the future radiotherapy workforce will look like. As such it is not clear what the future will hold for the profession. The quality and availability of radiation therapy for treating cancer is a concern for both the provision of services and for planning within the radiation oncology community.

An accurate projection of supply and demand positions the profession for the future in several respects. If too many professionals are trained, the resulting oversupply could lead to unemployment and lower wages. If too few training positions are available, the resulting undersupply could result in extended working hours and a lower quality of life for workers, and possible a delay in treatment delivery for patients. For optimal delivery of radiotherapy an adequate balance between the supply of, and demand for, trained professionals in the key disciplines needs to be ensured. Key disciplines are radiation oncologists, radiation therapists and radiation oncology medical physicists. This paper aims to review the current status

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and capacity of the three main disciplines that make up the radiation oncology workforce in Australia and project the workforce supply and demand for 2014 and 2019.

Materials and Methods

Data on workforce from all radiotherapy facilities operating in Australia in 2008 were collected using a facility survey. The facility survey was completed by all 52 radiation oncology facilities in Australia that were operational in 2008. The survey collected a wide range of data including the number of linear accelerators; the types of radiation oncology services provided, the number of patients treated; details on the radiation oncologists, radiation therapists and radiation oncology medical physicists positions filled and vacant at each facility; as well as local recruitment and retention issues for each profession. A separate professions' survey collected detailed information on qualifications, experience, employment status, hours worked and future working intentions of staff members. This survey was sent to 339 radiation oncologists, 1578 radiation therapists and 250 radiation oncology medical physicists, with response rates of 53.2%, 50.4% and 80.1% respectively.

Workforce supply and demand models were developed to project supply and demand in 2014 and 2019. This workforce projection model allowed a comparison of supply and demand for all three professions - radiation oncologists, radiation therapists, and radiation oncology medical physicists, taking into account the current age profile of the workforce, expected new entrants, and estimated attrition rates.

Supply side workforce models

All three supply side models are based primarily on the data collected using the professions' surveys of the radiation oncologist, radiation therapist, and radiation oncology medical physicist workforces. The professions' survey data provide a range of workforce characteristics including age distribution, working hours, year obtained qualifications, and retirement/workforce exit intentions. Although the response rates to the professions' surveys were high, they were not 100% and therefore a separate estimate of the number of professionals in the workforce was required. For this purpose, the facilities' survey data was used to "gross up" the professions survey figures and thereby provide a representation of the whole workforce assuming that the distribution of non-respondents' characteristics (e.g. age) would have been similar to the distribution for respondents.

For all the workforce groups the professions surveys also provided data on the number of practitioners planning on leaving the workforce (e.g. maternity leave, leaving the profession or travelling overseas). The relevant question on the professions survey was about the respondent's intentions to change their work arrangements over the next 12 months. Being only for 12 months, the numbers were multiplied by five to represent each of the five year future time periods projected. These data were used to estimate attrition for persons aged less than 45 years of age for radiation therapists and radiation oncology medical physicists (For RTs it was assumed that 95% of those planning on taking maternity leave or extended travel within the next 12 months would return within five years. For those who went to work overseas, it was assumed that two out of three would return within five years - based on the short duration most predicted they would be travelling in the professions survey.

For ROMPs, three professions' survey respondents reported that they would be going on maternity leave/ extended overseas travel, but they were offset by two who reported returning from maternity leave, thus no net gain or loss was assumed for maternity leave/extended overseas travel. For those ROMPs who responded that they planned to move overseas to work, it was assumed they did not return as a large proportion was returning to their country of origin.). For radiation oncologists, the professions survey data showed that the number of radiation oncologists planning to leave the Australian workforce was about equal to the number of inward migrants so a net zero impact was modelled for maternity leave and/or extended travel.

The radiation oncology medical physicists' professions' survey was used to estimate the number of retirees. For radiation therapists and radiation oncologists, ABS Census data and AIHW medical workforce survey data were used to estimate attrition from the workforce through retirement for persons aged 45 years and over (The professions' surveys designed for this project are cross-sectional and therefore do not provide data on the historical pattern of actual retirement rates.).

Attrition rates were calculated as the percentage reduction in each age cohort over the previous five years. Retirement rates after five years and 10 years were calculated for each five year age cohort. Net attrition (Net attrition accounts for movement both in and out of the workforce.) is the sum of the attrition for all previous periods. The calculation of cumulative attrition rates is as follows:

NAR = $1\text{-}N_{t(i)}/N_{t(1)}$

where: NAR = net attrition rate;

N = number in workforce;

$t_{(i)}$ = projection time period

(i = 5 at 2014 and i = 10 at 2019); and

$t_{(1)}$ = the first year of data in series

(in this case 2009)

New entrants to the workforce were modelled in a way that reflected the differences in arrangements for training the respective professionals groups. For radiation oncologists, the Royal Australian and New Zealand College of Radiographers (RANZCR) provided data on current registrars in training in 2009. The data were used, along with the age/sex profile of respondents to the professions survey to derive an estimate of 21 new medical registrars per year with an associated age distribution in five year cohorts and assumption that 53% would be female. For radiation therapist, the relevant Universities provided a projection of the number of new graduates. For radiation oncology medical physicists, the training situation is similar to radiation oncologist registrars so the number of radiation oncology medical physicist registrar positions was used from the facilities' survey. However, some of these positions were for qualified radiation oncology medical physicists but had been filled by registrars due to difficulties in recruiting a qualified person. As this scenario may not continue, 15 new radiation oncology medical physicist registrars per annum has been used in the base model but a scenario with only 10 new registrars per annum is included in the sensitivity analysis. Finally, the professions' survey was used to estimate the number of overseas migrants into the Australian workforce. For radiation oncologists and radiation therapists, there was little net impact from immigration, but the number of radiation oncology medical physicists recruited from overseas was significant and the model assumes an incoming number of four to five each year.

Demand side workforce models

Demand was based on an estimated head count for each of the radiation oncologist, radiation therapist and radiation oncology medical physicist workforces and the number of hours worked to provide the current level of radiotherapy services (i.e. current average staffing levels were used as the benchmark for future staffing levels). Average hours worked per week were reported by each of the respondents in the professions' surveys.

The demand model was incremental - it was assumed that the current level of radiotherapy provision is a baseline and there is addition demand generated by a number of factors (some of which are known, but most of which need to be estimated):

- the number of unfilled positions reported in the facilities' survey.
- the annual rise in cancer incidence – this figure implicitly accounts for population growth and ageing and the base model uses the figure 2.5% increase in new cases per year as advised by DoHA (the impact of variations is examined in sensitivity analyses).
- the workforce increase that would be required if Australia were to provide the number of services to achieve the target of 52.3% of patients with cancer receiving radiotherapy treatment that is recommended as best practice (Delaney et al., 2005). It was found that the best estimate of the current treatment ratio is 38.1% (Department of Health and Ageing, 2009) meaning that a further 14.2% of patients with cancer would benefit from radiotherapy treatment representing a further capacity requirement of 37% (14.2/38.1).
- the largely unknown impact of new technology. Data from the professions survey suggested that new technologies might require an increase in hours, of up to 15%, and the impact of a 5% and 10% increase was modelled in the sensitivity analysis.
- the increase/decrease in workforce that would be required to staff facilities at the recommended benchmark levels. This study found a reasonable degree of support for the benchmarks promulgated by the RANCR, the Australian Institute of Radiology (AIR) and the Australian College of Physical Scientists and Engineers in Medicine (ACPSEM). It uses 250 new patients per radiation oncologist per annum, the 1.06 radiation therapists per linac hour (modified for service complexity) and the 1.7 radiation oncology medical physicists per linac (modified based on facility equipment) in the sensitivity analysis to examine the workforce impact of achieving the recommended staffing ratios.

Results

Response rates to the professions' survey for radiation oncologists, radiation therapists, and radiation oncology medical physicists were high (53.2%, 50.4% and 80.1% respectively).

Radiation Oncologists

From the facilities' survey it was estimated that there were 339 radiation oncologists in 2009 (Table 1). Using the professions' survey data, it is estimated that 44% of the radiation oncologists were aged 45 years and over, with six radiation oncologists continuing to work over the age of 65 years; and that 62% of radiation oncologists were men.

By 2014, it is projected that there will be 431 radiation oncologists (Table 1). Over the five years from 2009, it is estimated that there will be about 105 new entrants and 13 retirees. By 2019, it is projected that there will be 495 radiation oncologists. Over the five years from 2015, there will be about 105 new entrants and 41 retirees. The greater number of retirees in this second five-year period reflects the larger size of the cohort aged 45 – 54 years in 2009 compared to the older cohort aged 55 to 64 years.

It was estimated that demand would grow to about 540 radiation oncologists by 2014 and 610 radiation oncologists by 2019 (about 24,850 hours per week by 2014 and 28,050 by 2019, based on the current average of 46 hours worked per week) (Table 2). This is 109 positions above the number of radiation oncologists projected to be available in 2014 and 115 above the available number in 2019.

Radiation Technologists

It was estimated that there were 1,578 radiation therapists in 2009 (Table 1). The professions' survey data shows that radiation therapists are a relatively young workforce with only 25% aged 45 years and over, and only four radiation therapists continuing to work over the age of 65 years. radiation therapy is a largely female profession with 75% of radiation therapists being women.

By 2014, it is projected that there will be 1,836 radiation therapists (Table 1). Over the five years from 2009, it is estimated that there will be about 746 new entrants and 490 radiation therapists leaving the profession. There were large numbers of professions' survey respondents indicating that they planned to leave the profession, move overseas, take maternity leave or undertake extended travel overseas (It was assumed that 95% of those taking maternity leave or extended travel would return within five years.) in addition to retirees. Turnover is the main driver of loss to the radiation therapy workforce. By 2019, it was projected that there would be 2,171 radiation therapists. Over the five years from 2015, there would be about 776 new entrants and 440 exits from the radiation therapist workforce.

Table 1. Workforce Supply Projections to 2019

Radiation oncologists														
Age at 2009	-	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	Total
Radiation oncologists 2009	-	-	28	46	64	53	52	42	31	17	4	0	2	339
Age at 2014	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+	Total
Radiation oncologists remaining 2014	-	56	56	54	77	52	45	45	33	11	2	0	0	431
Age at 2019	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Radiation oncologists remaining 2019	56	85	63	67	75	51	47	30	14	5	1	0	0	459
Radiation therapists														
Age at 2009	-	-	-	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	Total
Radiation therapists 2009	-	-	-	232	341	225	252	134	111	162	83	35	4	1578
Age at 2014	-	-	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	Total
Radiation therapists remaining 2014	-	-	528	213	357	195	242	111	72	65	50	0	0	1836
Age at 2019	-	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	Total
Radiation therapists remaining 2019	-	554	511	231	329	186	219	73	29	39	0	0	0	2171
Radiation oncology medical physicists														
Age at 2009	-	-	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	Total
Radiation oncology medical physicists 2009	-	-	10	56	30	43	25	33	26	11	8	8	1	250
Age at 2014	-	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	Total
Radiation oncology medical physicists remaining 2014	-	5	78	62	35	51	28	34	21	6	1	0	0	319
Age at 2019	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	Total
Radiation oncology medical physicists remaining 2019	5	73	83	66	43	53	29	28	15	0	0	0	0	396

It was estimated that demand would grow to about 2,447 radiation therapists by 2014 and to 2,764 by 2019 (about 88,100 hours per week by 2014 and 99,500 by 2019 based on the current average of 36 hours worked per week) (Table 2). This is 612 positions above the number of radiation therapists projected to be available in 2014, and 593 positions in 2019. Despite this apparent gap, there were a notable number of respondents who were uncertain about their contracts being renewed or whether they would be able to continue to find employment as a radiation therapist. The main reason for the emerging apparent gap appears to be the very large proportion of the radiation therapy workforce who leaves the profession at a relatively young age.

There are several sources of measurable unmet demand. There are 31 unfilled positions (about 1,120 hours per week) (Table 2). The increase that would be required to deliver best practice care, an increase of 37%, was 557 radiation therapists (about 20,050 hours per week). The growth in cancer incidence (2.5% annually) generates an increase in demand of 281 radiation therapists by 2014 and 598 radiation therapists by 2019 (about 10,100 hours per week by 2014 and 21,500 hours per week by 2019), the largest factor estimated in driving future demand.

Radiation Oncology Medical Physicists (radiation oncology medical physicists)

From the facilities' survey it was estimated that there were 250 medical physicists in 2009 (Table 1). The professions' survey data shows that 35% were aged 45 years and over, with nine medical physicists continuing to work after the age of 65 years. It also shows that 67% of medical physicists are male.

By 2014, it was projected that there would be 319 medical physicists (Table 1). Over the five years from 2009, it is estimated that there will be about 97 new entrants (including migrants entering the Australian workforce net of those planning on leaving the Australian workforce, The impacts of policy changes such as priority on the immigration list would depend on the number, timing and the age of the immigrants) and 28 retirees (It is likely that the number of medical physicists indicating in the professions survey that they would retire in the 12 months from 2009 is slightly higher than the annual average. Projecting these figures forward suggests that by 2019 all medical physicists over the age of 65 years would have retired when there would have been expected to have been about 10-15 in this age group still in the workforce based on the 2009 age distribution. As a result, total supply in 2019 may be underestimated by about 10-15 medical physicists. However, if the high rate of migration of medical physicists was to decline this potential underestimate would be would quickly offset.) (Table 10.5). By 2019, it was projected that there would be 396 medical physicists. Over the five years from 2015, it was estimated that there would be about 97 new entrants

Table 2. Workforce Demand Projections to 2019

	Radiation Oncologists		Radiation Therapists		Radiation Oncology medical physicists	
Demand Factor	2014	2019	2014	2019	2014	2019
Average hours worked per week	46	46	36	36	40	40
Total workers in 2009	339	339	1578	1578	280	280
Total hours worked per week	15,594	15,594	56,808	56,808	10,000	10,000
Unfilled positions 2009	14	14	31	31	35	35
Total unfilled hours per week worked	644	644	1,116	1,116	1,400	1,400
Increase in capacity required to achieve best practice (treatment rate)	37%	37%	37%	37%	27%	27%
Extra positions needed to achieve best practice (treatment rate)	126	126	557	557	67	67
Best practice hours per week worked	5.812	5.812	20,057	20,057	2,673	2,673
Trend increase in cancer incidence per annum	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Extra positions needed due to increase in cancer incidence	61	130	281	598	42	89
Total additional hours per week required due to increase in cancer incidence	2,813	5,995	10,100	21,529	1,665	3,550
Total demand	540	610	2,447	2,764	393	441
Total demand (hours per week)	24,863	28,045	88,081	99,509	15,738	17,623
Projected supply	431	495	1,835	2,171	319	396
Shortfall	109	115	615	593	74	44

and 19 retirees. These figures assume that the number of medical physicists migrating from overseas to Australia will be maintained.

It was estimated (Table 2) that demand would grow to about 423 medical physicists by 2014 and 474 by 2019 (about 16,950 hours per week in 2014 and 19,000 in 2019 based on the current average of 40 hours worked per week). By 2014, this is 104 positions above the number of radiation oncology medical physicists that is projected to be available and 78 positions in 2019.

There are several sources of measurable unmet demand. There are currently a number of unfilled medical physicist positions, 35 in all (about 1,400 hours per week) or about 15%, the highest proportion of any of the three professions included in this study. The increase that would be required to deliver best practice care, an increase of 37% over current provision of radiation oncology, accounts for a further 93 positions. The growth in cancer incidence (2.5% annually) is projected to result in an increase in demand of 45 medical physicists by 2014 and 96 medical physicists by 2019, the largest factor estimated in driving future demand.

Sensitivity analysis

The workforce model was designed to allow the impact of varying a number of assumptions to be tested. In so doing, it is important to note that some factors were modelled as once-off changes to current practice. These factors include changes to best practice treatment rates, impacts of new technology, and changes to recommended staffing levels. This is the correct treatment of such factors as once staffing levels have been adjusted to absorb the one-off impact then the models project staffing needs going forward from the new base. That is the impact of the factor does not compound each year, like for example the growth in cancer incidence.

Using the models, we found that the estimates of demand were particularly sensitive to the rate of growth in cancer incidence. Table 3 shows that an increase of 0.5% over the base estimate of 2.5% per annum to 3.0% per annum would result in an additional workforce demand for 13 radiation oncologists, 59 radiation therapists and 10 radiation oncology medical physicists over five years

Table 2. Workforce Model Sensitivity Analysis Impacts to 2019

Scenario	2014 Projection	2014 Difference from base	2019 Projection	2019 Difference from base
Radiation oncologists – demand:				
Base projection	540		610	
Cancer increase - 3% pa	553	13	639	29
Cancer increase - 2% pa	528	-12	581	-29
Demand due to technology - 5% increase	564	24	633	23
Demand due to technology - 10% increase	587	47	656	46
RANZCR recommended staffing levels*	490	-50	559	-51
Radiation therapists – demand:				
Base projection	2,447		2,764	
Cancer increase -3% pa	2,506	59	2,900	136
Cancer increase -2% pa	2,388	-59	2,634	-130
Demand due to technology - 5% increase	2,553	106	2,871	107
Demand due to technology - 10% increase	2,660	213	2,978	214
AIR recommended staffing levels*	2,683	236	3,001	237
Radiation oncology medical physicists –supply:				
Base projection	319		396	
Registrar numbers – 10 per annum	294	-25	346	-50
Radiation oncology medical physicists – demand:				
Base projection (demand)	423		474	
Cancer increase - 3% pa	433	10	496	22
Cancer increase - 2% pa	414	-9	453	-21
Demand due to technology - 5% increase	440	17	491	17
Demand due to technology - 10% increase	458	35	509	35
ACPSEM recommended staffing levels*	526	103	577	103

*Based on a ratio relative to current staffing of 0.85 for radiation oncologists, 1.15 for radiation therapists and 1.41 for radiation oncology medical physicists; Note: figures may not sum due to rounding and 29 radiation oncologists, 136 radiation therapists, and 22 radiation oncology medical physicists over the ten years when compared to the base scenario. A decrease of 0.5% to 2% per annum would reduce workforce demand by 12 radiation oncologists, 59 radiation therapists and nine medical physicists and 29 radiation oncologists, 130 radiation therapists, and 21 radiation oncology medical physicists over 10 years.

Having regard to the difficulty in predicting the workload impact of new technologies, 5% and 10% increase in workload scenarios were modelled. The model shows that if new technology required a 5% increase in hours to treat the same number of patients, an additional workforce demand of about 24 radiation oncologists, 106 radiation therapists, and 17 radiation oncology medical physicists would be created. A 10% increase in hours to treat the same number of patients due to new technology would lead to an additional workforce demand of 47 radiation oncologists, 213 radiation therapists and 35 radiation oncology medical physicists. Note that there is no difference in the projected impact of new technology over 5-10 years because the impact is modelled a one off change to the base staffing numbers.

The sensitivity analysis also examined what would be required to staff facilities at the levels currently recommended by the respective professional bodies. Given the limitations of the facilities' and professions' surveys, this estimate could only be made at the national level (public and private facilities combined) by applying a ratio to the current practice benchmarks derived in chapter 5. Using this approach, if facilities were staffed at a level recommended by the professional bodies, there would be a decrease in demand of 50 radiation oncologists and an increase in demand of 236 radiation therapists and 103 radiation oncology medical physicists. Again there is no difference in the projected impact of recommended practice staffing over 5-10 years because the impact is modelled a one off change to the base staffing numbers.

The number of radiation oncology medical physicists entering the workforce depended on funding for registrar positions. Because there is some doubt as to the continuity of registrar training at current levels (i.e. some radiation oncology medical physicist registrars currently occupy qualified staff positions and it is argued that this situation will not be repeated), a lower scenario of 10 new radiation oncology medical physicist registrars per year was also modelled. At this level, the radiation oncology medical physicist supply would fall to 294 in 214, 25 fewer than if there were 15 new radiation oncology medical physicist registrars per year and 346 radiation oncology medical physicists in 2019, 50 fewer than if there were 15 new radiation oncology medical physicist registrars per year. Clearly, this outcome would accentuate the already severe shortage of radiation oncology medical physicists that is predicted by the workforce model (i.e. moving from a shortage of 74 radiation oncology medical physicists in 2014 in the base model to a shortage of 99 radiation oncology medical physicists in 2014, i.e. 25% less than what is required).

Discussion

This study found that there will be a future shortfall of radiation oncologists, radiation therapists and radiation oncology medical physicists working in radiation oncology treatment. By 2014 there will be 109 fewer radiation oncologists than what will be demanded, and by 2019 this figure will increase to a shortfall of 155 radiation oncologists. There was a projected shortfall of 612 radiation therapists by 2014, with this figure slightly decreasing to a shortfall of 593 radiation therapists in 2019. In 2014, there was projected to be a deficit of 104 radiation oncology medical physicists and a shortfall of 78 radiation oncology medical physicists in 2019.

The supply of radiation oncology workers is crucial. The overall number of individuals with cancer is increasing in line with the population ageing, as cancer is more common in older age groups (Begg et al., 2003). By 2016 it is expected that cancer will overtake cardiovascular disease as the leading cause of death, as cardiovascular treatment and prevention are progressing at a faster rate (Mathers et al., 2000). Internationally it has been documented that there is a general shortfall in radiotherapy workers and this is expected to continue into the future (Rivera et al., 2004; The Royal College of Radiologists, 2005; National Radiotherapy Advisory Group, 2007; Mills et al., 2010). However, until now there has been no detailed projection of the future of the Australian radiation therapy workforce, although the future shortfall has been speculated upon (Committee, 1998; Jones et al., 2000). The sensitivity analysis showed that for all the changes in the assumptions there would still be a deficiency in the number of workers in the future.

The study documented the age and sex profile of workers in Australian radiation oncology. radiation oncologists were the 'oldest' profession with 44% of radiation oncologists being aged 45 years or over in 2009; compared to only 25% of radiation therapists aged over 45 years and only 35% of radiation oncology medical physicists being aged over 45 years. This makes radiation oncologists particularly susceptible to the retirement of many experienced workers, an occurrence currently being experienced in numerous medical professions within Australia (Australian Institute of Health and Welfare, 2003; Australian Medical Workforce Advisory Committee, 2004; Australian Institute of Health & Welfare, 2008; Schofield et al., 2009). This trend is largely driven by the ageing of the Australian population (Productivity Commission, 2005), which is seeing an increasing proportion of the Australian workforce in general approach typical retirement age. The general ageing of the population not only creates an increased demand on the heath system – with many health conditions, including cancer, increasing in prevalence with age (Begg et al., 2003) – but will also reduce the numbers in the workforce (Productivity Commission, 2005). The imminent retirement of experienced medical workers, such as older radiation oncologists, has been recently highlighted for its impact on the education and training of incoming younger workers (Schofield et al., 2009). With the retirement of older, experienced workers who have traditionally taken on the role of educators, there may be a shortfall in the availability of radiation oncologists to educate new recruits in universities.

The shortfall in radiation oncology workers is largest for radiation therapists – with a deficit of over 500 workers expected in the years 2014 and 2019. The study indicates that one of the key reasons for this gap may be due to profession exit at a young age (specifically due to moving overseas, maternity leave, travelling overseas, or seeking another profession). A high rate of radiation therapist attrition has also been reported in the UK (Department of Health, 2003), and has been previously recognised in Australia (Baume, 2002; Allied Health Professional Workforce Planning Group, 2003). It has been noted that attrition from the nuclear medicine technologist workforce commences from age 30 and that there are few older workers (Adams et al., 2008) – which is confirmed in this study. This high attrition rate of technologists and the large shortfall in workers has seen recent studies investigating their working environment (Adams et al., 2008, 2010). It has been concluded that changes to job resources and job practices could help retain workers (Adams et al., 2010). The study also found that a large number radiation therapists who responded in the survey stated that they were unsure about having their contracts renewed and their chances of finding work in the profession. This seems to be at odds with the findings of this study that indicates that radiation therapists should be in high demand. There may need to be a coordinated effort to change the culture within radiation therapist practice and recruitment to emphasis the value of current radiation therapist workers for the future of cancer treatment.

The future projected shortage of radiation oncologists, radiation therapists and radiation oncology medical physicists highlights the need for radiation oncology workforce planning. Internationally there have been numerous attempts to plan for the future of the radiotherapy workforce in light of the expected shortfalls in supply and increasing demand (Rivera et al., 2004; The Royal College of Radiologists, 2005; National Radiotherapy Advisory Group, 2007; Mills et al., 2010). Indeed the long training timeframe involved in radiotherapy related occupations – 15 years for radiation oncologists and 9 years for radiation oncology medical physicists (Royal Australian and New Zealand College of Radiographers, 2002), highlights the need for a focus on the future of the workforce and long term planning. Within the U.S, a report on radiation oncologists has set yearly goals that are required to be met to ensure that the supply of radiation oncologists keeps up with demand (Mills et al., 2010). This study has estimated what the shortfall of radiation oncologists, radiation therapists, and radiation oncology medical physicists will be in Australia in 2014 and 2019, to allow workforce planning. Australia already has a National Strategy for radiation Oncology, which was developed in 2001 (Baume, 2002), and RANZCR has committed the need for workforce planning (The Royal College of Radiologists, 2005). This study highlights the need for continual efforts to best manage existing workers and to recruit new ones, and the potential value of professions' and facilities' surveys and the need for them to be repeated at regular intervals for the purposes of ongoing workforce monitoring.

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