

Faculty of Radiation Oncology 2018 workforce census: the status of the radiation oncology workforce in New Zealand

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ABSTRACT

AIM: This paper outlines the results of the Royal Australian and New Zealand College of Radiologists (RANZCR) Faculty of Radiation Oncology (FRO) 2018 workforce census. Here we report the responses of New Zealand radiation oncologists and trainees in order to understand characteristics of the New Zealand radiation oncology workforce.

METHOD: The workforce census was conducted online during July–September 2018. Distribution was by Survey Monkey to all radiation oncologists (fellows, life members, educational affiliates, retired) and trainees on the RANZCR membership database, including members from Australia, New Zealand and Singapore. All responses were aggregated for analysis. This paper addresses only responses from New Zealand members. The census was designed to explore issues relevant to the New Zealand workforce, and questions from previous workforce censuses were repeated in order to monitor trends.

RESULTS: The response rate for New Zealand radiation oncologists was 73.3% (44/60). The majority (67%) were male. The average age was 50.8 years. Three-fifths (59.5%) reported New Zealand ethnicity. One-third obtained their specialist qualifications outside of Australia and New Zealand. Most worked in the public sector only (63.4%), with only two in exclusive private practice. Most radiation oncologists attained a consultant post immediately on completion of training, but there were 26 who pursued an overseas fellowship. Most worked one full-time equivalent or greater (FTE), with 17.5% working less than 1.0 FTE. Radiation oncologists reported working a median of 50.0 hours per week, with half working over 10 hours above their contracted hours. Most time was spent on clinical duties with minimal time spent on research. Radiation oncologists reported seeing an average of 235 new patients per year (median: 230). Leadership positions were held by 21/43 respondents. Within 15 years, 55% of the current workforce reported an intention to retire, including 30% of those currently practising highly specialised brachytherapy. Females in the workforce were less likely to work fulltime and spent less time in research and management activities. All trainees reported full-time work, although 50% expressed a desire for part-time training. Half of the trainees reported working 6–10 hours on call, and 60% reported two or less hours of protected teaching per week. Despite this, 90% of trainees were satisfied with their career choice.

CONCLUSIONS: Radiation oncology is a small specialty in New Zealand, with a significant reliance on overseas-trained specialists. The specialty continues to work significant overtime hours while time spent on research and non-clinical duties remains low. The growth in staffing between the 2014 and 2018 census has been low. Trainee numbers do not appear sufficient to meet the demand for replacing staff, due to retirements and the reduction of hours. Radiation intervention rates are low in New Zealand, but growth would be reliant on an expansion of the workforce beyond simply replacing staff losses. The radiation oncology workforce in New Zealand remains vulnerable, and careful consideration must be given to expansion and retention to ensure a viable workforce for the future.

Health workforce planning requires a complex interplay of factors: changing workforce demographics, the education required for the appropriate skill set (a time lag for training means the workforce cannot rapidly adapt to increases in the number of skilled personnel required), recruitment and retention, organisational culture and the demand (again, a complex interplay of incidence, changes in population demographics and other treatment options). Radiation oncology is integral to cancer care, with one in two cancer patients estimated to benefit from radiation treatment.³ Thus, workforce planning is vital to ensure this crucial service is able to meet future needs. This article presents the results of the sixth Royal Australian and New Zealand College of Radiologists (RANZCR) radiation oncologist and trainee workforce census, surveying the Australian, New Zealand and Singaporean membership (see Appendix 1).¹ Here we concentrate on the New Zealand responses, which provide a self-reported snapshot of the current radiation oncology medical workforce in New Zealand and inform us of workforce demographics, patterns of work, potential changes in retention, organisational structure and the thoughts of those who are in training and who may be recruited to positions in the future.

Previous RANZCR workforce surveys were performed in 1996, 2000, 2006, 2010 and 2014. In 2014, for the first time, analysing results by country was possible.² This analysis indicated some unique issues facing the New Zealand workforce and provides a basis to analyse trends and inform future planning.

International radiation oncology workforce studies have indicated a number of themes, including demographics of the workforce (including diversity), work (hours, type and context) and trainee needs.^{4,5} This survey enables us to explore those themes in the New Zealand radiation oncology workforce and compare with international trends and, also, with data reported for other specialties within New Zealand.

Methods

The Faculty of Radiation Oncology workforce census ran from July to September 2018 and was hosted on Survey Monkey. A link inviting participation was sent to all

active radiation oncologists and registrars in the RANZCR membership database. Weekly reminders were sent until closure.

Census questions were designed by the Faculty of Radiation Oncology Economics and Workforce Committee. Questions from previous censuses were repeated to monitor trends, and additional questions were added to explore current issues, such as time spent in multidisciplinary clinics and involvement in leadership and issues relevant to New Zealand, such as brachytherapy specialisation.

Questions in the survey followed logical rules guided by previous responses. For example, a person who identified as retired would not be asked questions regarding work hours.

Statistical analyses, including independent samples t-tests, Chi-squared, and Mann-Whitney U tests, were performed where appropriate using IBM SPSS Statistics v19 software (Armonk, NY: IBM Corp).

Results

Eligible study sample

The census was sent to 654 members and 457 responded (69.9%). In New Zealand, the survey was sent to 86 with 63 responses (73.3%) (Table 1).

This table indicates the proportions within the membership categories were similar, indicating a low likelihood of non-responder bias. The ratio in the retired member category is lower at 50%, but as these were excluded from subsequent analyses, the effect on outcomes was not thought to be significant. For further analyses, the term radiation oncologists included all those eligible to practise as a specialist in radiation oncology in New Zealand (including fellows, life members and educational affiliates).

Radiation oncologists

Demographics

The RANZCR membership database identified 60 radiation oncologists in New Zealand, 44 (73.3%) of whom responded to the census (Table 2). There were 19 radiation oncologists in New Zealand who obtained their specialist qualifications outside of Australia and New Zealand. There were 42 responses to the question about year of graduation, with 29 (69.1%) graduating between

Table 1: Population of radiation oncologists/trainees in New Zealand.

Category	N (population)	N (respondents)	Response rate (%)
Fellows	54	40	74%
Retired members	4	1	25%
Students	22	18	81%
Educational affiliates	4	2	50%
Life members	2	2	100%
Total	86	63	73%

Table 2: Demographics of New Zealand radiation oncologists and radiation oncology trainees.

Variable		
Gender	Radiation oncologist N (%)	Trainee
Male	40 (67%)	14
Female	20 (33%)	8
Total	60*	22
Male to female ratio	2:1	1.75:1
Age	Radiation oncologist N (%)	Trainee
25–29	0	2 (9)
30–39	7 (11.7%)	19 (86.4)
40–49	23 (38.3%)	1 (4.6)
50–59	17 (28.3%)	0
>60	13 (21.7%)	0
Total	60*	22*
Average (years)	50.8	32.8
Median (years)	49.5	33
Ethnicity	Radiation oncologist N (%)	Trainee
New Zealand	25 (59.5%)	6 (33.3)
Asian	7 (16.7%)	9 (50%)
European	3 (7.1%)	2 (11.1)
Other	7 (16.7%)	1 (5.6)
Total	42 (100)**	18 (100)**
FTE	Radiation oncologist N (%)	Trainee
<1.0	7 (17.5%)	0
1.0	20 (50%)	22 (100)
>1.0	13 (32.5%)	0

*Survey data supplemented with membership data.

**Numbers vary with number responding to each question.

1975 and 1995, 10 (23.8%) between 1996 and 2005 and only three (7.1%) between 2006 and 2018. Eight reported holding a higher degree, including five with a doctorate (MD, PhD).

Immediately after graduation, three reported acting in a locum position, 18 reported working as a fellow and 26 reported becoming a consultant immediately. Most fellowship positions were undertaken overseas.

Work

Members were asked their full-time equivalent (FTE) status, with 0.1 FTE being four hours and 1.0 FTE five days (see Table 2). The reported average actual hours worked was 47.4 (range: 2.0 to 64.0 hours; median: 50.0). There were 22/41 (53.6%) who reported working over 50 hours per week, with 15/41 (48.4%) working over 10 overtime hours. There were significant differences when work times were compared with Australian data (Table 3).

Most of the work time was spent on clinical duties (attendance at multidisciplinary team meetings, consultations, simulation, dosimetry and contouring) (average: 31.5 hours; median: 27.0). Respondents also reported non-clinical tasks. Between 1 and 10 hours per week (average: 2.8) were spent supervising trainees, and 1 to 20 hours (average: 4.1) was spent on management. Of the 24 respondents to the question, 17 (70.1%) reported doing one hour or less per week of research (average:

2.3 hours). Australian colleagues reported a 30% higher average of 3.3 hours per week.¹

There were 26 (63.4%) respondents working exclusively in the public sector, 13 (31.7%) in a public/private mix and two (4.9%) exclusively in the private sector.

On average, respondents saw 234.8 new patients per year (range:30-400; median:230.0).

There were 33 (82.5%) who reported having hospital admitting rights, with the majority (85.0%) seeing this as valuable.

Two-thirds of respondents (67.5%) reported some specialist areas of practice (Figure 1). Stereotactic radiation and breast were the most common specialist areas.

Brachytherapy is a specialised radiation technique using radioactive sources placed directly into the patient, most often for prostate and gynaecological cancers. Of those 19 working in brachytherapy, 13 practice gynaecological brachytherapy and three intended to cease practice. Interrogation of this data finds that 30% of those practicing gynaecological brachytherapy were 60 years old and over.

There were 21 respondents who practise stereotactic radiation treatment (high-dose radiation given to small tumours), with 18/21 using this technique for lung cancer and 15/21 for brain tumours.

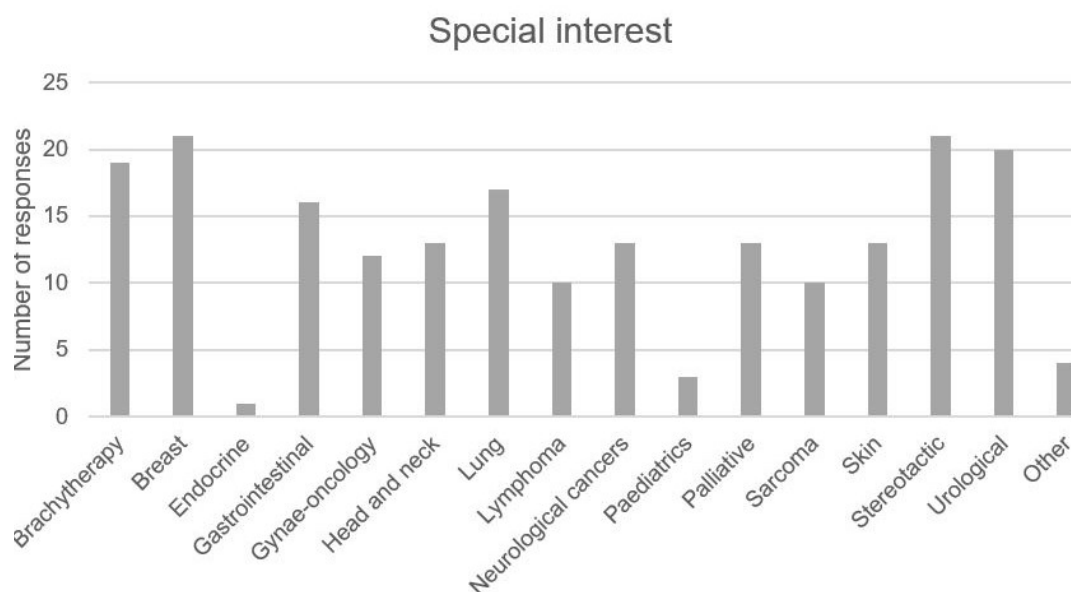
Of the 43 respondents, 21 held at least one leadership position, including leadership at the hospital level, network, college and in the national arena.

Table 3: Reported clinical activity hours.

Activity	New Zealand	Australia	P-value (t-test)
Total clinical hours	31.5 (3.0–94.0)	35.6 (2.0–532.0)	0.211
Multidisciplinary meetings	5.6 (1.5–57.0)	4.1 (0.5–55.0)	0.325
New cases	6.1 (1.0–12.0)	6.5 (1.0–20.0)	0.330
Follow-ups	6.9 (1.0–25.0)	8.6 (1.0–30.0)	0.025*
On treatment cases	2.7 (1.0–8.0)	4.5 (1.0–30.0)	0.000**
Simulation	2.3 (1.0–5.0)	2.3 (1.0–10.0)	0.944
Dosimetry	2.7 (1.0–5.0)	2.7 (1.0–15.0)	0.871
Contouring	6.0 (1.0–15.0)	8.3 (1.0–460.0)	0.285

*Significant at $p < 0.05$.

**Significant at $p < 0.01$.

Figure 1: Areas of specialty interest.

Future plans

Nearly two-thirds of respondents (62.5%; n=25) reported no plans to change their hours within the next three years and one-quarter (25%; n=12) intended to decrease hours, whereas only three (7.5%) indicated they planned to increase their hours (Table 4).

Table 4: Retirement plans.

Retirement plans	N (%)
No plans for retirement	18 (45)
Intention to retire in the next 5 years	7 (17.5)
Intention to retire in the next 6–10 years	5 (12.5)
Intention to retire in the next 11–15 years	10 (25)
Total	40 (100%)

Female radiation oncologists

Data indicated that more female radiation oncologists worked less than 1.0 FTE than males (1.3:1). A similar number of new patients per year were seen, with females reporting seeing an average of 229.8, and males 240.4.

Work-type differences were noted. Females reported lower research hours, with a range of 1–2 hours per week

(average of 0.5 hours), compared with males who reported a range of 1–24 hours (average of 2.1 hours). Of the 21 involved in leadership positions, eight were female (38.1%) and 13 were male (61.9%), which would correlate to the slightly lower time spent in management activities (females averaged 3.1 hours, compared to 3.6 hours reported by males), and males reported spending more time per week on jurisdictional activities (2.1 hours vs 1.1 hours, $p < 0.05$). Statistically significant differences in clinical work were found with female radiation oncologists spending more hours per week on dosimetry and simulation than their male colleagues (2.9 hours vs 1.9 hours, $p < 0.05$; 3.5 hours vs 2.3 hours, $p < 0.05$, respectively).

Radiation oncology registrars

Demographics

There were 24 radiation oncology trainees in six training centres in New Zealand. There were 18 trainees who responded to the survey, with respondents from across the five years of training (Table 2).

Prior to entering radiation oncology training, seven (38.9%) had other degrees (five in the sciences and two in nursing). One had a further specialist qualification. Common reasons for choosing a career in radiation oncology included an interest in oncology patients (83.3%; n=1), lifestyle (72.2%; n=13), work hours (61.1%; n=11) and family considerations (55.6%; n=10).

Work

The trainees all reported working full time. Nearly half (44.4%; n=8) indicated a desire to train part time, while 38.9% (n=7) wished to have a part-time specialist post. The reasons included maternity leave, family commitments and lifestyle.

Three-quarters of trainee respondents (77.8%; n=14) reported spending more than 36 hours per week discharging clinical duties and 83.3% (n=15) reported more than six hours per week on after hours on call (half reported working between 6 and 10 hours per week).

Time in radiation planning is important for a trainee to learn the technical aspect of radiation oncology. Trainees most commonly have five hours or less in planning a week (83.3%; n=15), with only three (16.7%) reporting between 6 and 10 hours. Despite being in training, 61.1% (n=11) of the trainees reported two or less hours of protected time for teaching, with three reporting no time.

Only half (n=9) reported that they had enough time to pursue interests outside of work.

Future plans

Most trainee respondents (88.9%; n=16) were satisfied with their career choice, with one unsure and one unsatisfied. Trainees reported multiple concerns for the future. The most common were job availability (88.9%; n=16), fellowship opportunities (38.9%; n=7), concerns with declining government resources (27.8%; n=5) and being "forced" to work in a rural area (11.1%; n=2). When reporting causes of stress, three-quarters (n=14) had concerns with training demand, two-thirds (n=12) reported concerns with either balancing responsibilities or with job demands, 61.1% (n=11) with training in remote centres and 44.4% (n=8) were concerned with future job prospects. The mandatory rotation within the training programme was reported as a significant cause of stress.

Although one-third of trainee respondents (n=6) had considered leaving the specialty, all reported their intention was to continue at the time of the census.

A significant proportion intended to complete a fellowship after training (66.7%; n=12), with three being undecided). Three-

quarters of trainee respondents (77.8%; n=14) intended to have a mix of private and public work and the majority (94.4%; n=17) also hoped to have an academic component.

Discussion

The first thing we note is that the workforce in radiation oncology is small. At the time of the census, there were 60 practicing radiation oncologists with 22 oncologists in training. The small size of the workforce renders it vulnerable to fluctuations in supply and demand.

Radiation oncologists

Demographics

To explore trends over time and internationally, the demographic data from the survey was compared with data from the 2014 census and national and international data.

The number of fellows in the 2014 census was 56, indicating only minimal growth of four radiation oncologists over the four years.² The 2014 data reported 23% (14/60) of radiation oncologists were greater than 60 years of age, with 12% (7/60) under than 40.² The current survey indicates very similar proportions in these age brackets, with no recent influx of younger practitioners. This contrasts with the Canadian data and American data, which reported a greater proportion in the younger age brackets. In 2018 the Canadian radiation workforce consisted of 30% under 40 years of age (171/567), and in 2017 the American workforce, 20.1%.^{4,5}

One-third of the radiation oncologists on the membership database were female, unchanged from 2014. The percentage of females in the medical workforce in New Zealand overall in 2018 was 45.1%. This data includes resident and prevocational doctors.⁶ The data for medical specialists in New Zealand indicates the proportion of females in 2018 was 39.2%, slightly higher than the proportion of females in radiation oncology.⁷ The higher ratio of female participation in the radiation oncology workforce for those under 40 may suggest that the trend is following the general medical workforce figures, and that higher rates of female participation may be seen in the future, reflecting international trends. The Canadian workforce report indicates

that from 1990 to 2018 the proportions of females in the workforce rose from 18% to 38% for the radiation oncology workforce overall and from 28% to 50% for trainees.⁵

In both the 2014 and 2018 censuses, three-quarters of respondents reported exclusively public practice.² This contrasts markedly with the Australian data, where there has been a substantial increase in the private sector, with the census overall revealing nearly one-third working solely in the private sector.¹

The proportion of radiation oncologists receiving their specialist qualifications outside of Australia and New Zealand was high at 32% (19/60), similar to 2014 data. This brings a breadth of experience, but a continued reliance on the overseas market increases vulnerability as international supply and demand fluctuates and international regulations change. Interestingly, this is not a challenge unique to radiation oncology, as the 2018 national medical workforce survey indicates 40.1% of the New Zealand national medical workforce are international medical graduates.⁶

There was 58% of the radiation oncology workforce reporting New Zealand ethnicity and the next largest reporting Asian ethnicity (16%). When compared with the national medical workforce in 2018, 54.5% reported New Zealand ethnicity and 11.2% Asian.⁶ It would be essential in future surveys to explore more detailed breakdown of New Zealand ethnicity, in order to ascertain the proportions of Māori and Pasifika within the workforce. Within the general medical workforce in New Zealand, Māori make up 3.5% of doctors compared with 14.7% of the population, and Pasifika less than 2% compared with 7% in the general population.⁶ It is a RANZCR priority to explore and address this imbalance.

The concerning trends highlighted by the demographic data are that the workforce is small, is only slowly growing, remains heavily reliant on overseas trained doctors and faces the potential challenge of clinicians moving into the private system and putting further pressure on services in the public health system. Ministry of Health consideration of increasing the funding for training posts in radiation oncology is urgently required. Programmes addressing recruitment must also consider increasing

diversity within the profession, particularly with regards to Māori, Pacific Island and female participation. Considerations to increase diversity would include provisions for part-time training, scholarships and radiation oncology information sessions and house surgeon and medical student teaching programmes and “career fares”.

Work

The median contracted hours was 40, and actual hours worked was 50, in both the 2014 and 2018 surveys.² Of concern, however, was a higher proportion working over 10 overtime hours per week. (35.1% in 2014 and 48.4% in 2018),³ once more higher than our Australian counterparts.¹ Thus, the trend to work significantly longer hours than contracted at least continues and may have worsened.

The median contracted hours and the median clinical hours worked was similar, indicating that time must be made outside of this for administration, teaching and research. This was reflected in the fact that 82% of respondents reported doing one hour or less of research a week, similar to the 2014 report.² International research concludes that involvement in clinical trials provides benefits to patients, even for those patients not directly enrolled themselves.⁹ Because of this, a draft New Zealand National Oncology and Haematology National research strategy process document has recommended that clinical trials be “incorporated as standard clinical practice”, but this document also reports that “across New Zealand, enrolment in clinical trials is lower than international recommendations and benchmarks, even in large metropolitan centres”.¹⁰ A study from the UK found that “dedicated time and funding were the biggest barriers for doctors becoming involved in research”.¹¹ This challenge of dedicated time would appear to be a problematic barrier to research in radiation oncology within New Zealand.

For clinical tasks, the reported median number of new patients seen per week of 6.1 was similar to 2014 responses (6.0).³ The median new patient numbers also remained similar (245 in 2014, 235 in 2018).³ The time spent on contouring was not reported in the previous censuses; however, this census reported it was a significant component of the work undertaken, with a median of 6 hours (range: 1–15 hours). This is a

change over the last decades of radiation treatment, as we moved away from simple x-ray simulation, and is in line with international data. The German Society of Radiation Oncology reported on time measurements for the process of radiation and found that the technical processes (contouring and assessing and approving a plan) was the most time consuming, requiring on average 3 hours and 54 minutes per patient for intensity modulated radiation treatment (IMRT).¹² The increased time taken for this has been “absorbed” into existing staffing levels and may be reflected in the increased out-of-contracted hours work. This would be consistent with the RANZCR survey of trainees, which found 80% spent time “out of hours” contouring.¹³

Specialist radiation techniques require consideration, as only a proportion of the workforce possess these skills. A potential area of vulnerability is in gynaecological brachytherapy, where 30% of the 10 practising are over 60 years of age.

The workforce census highlighted an involved and engaged workforce, with almost 50% reporting they held at least one leadership position. The fact that many held more than one points to the problem of a small number of clinicians attempting to hold posts across many domains.

On reflection of the work trends for radiation oncologists, increasing overtime hours indicates a need for modern job sizing activities to be performed. The historical measure of numbers of patients does not account for complexity of treatments, and this must be considered to ensure adequate radiation oncology resource. Job sizing must also reflect the need to move the essential contouring hours to within working hours, as well as allowances for time to perform research, leadership, administration and teaching as essential facets of a radiation oncologist role. Recruitment must ensure that New Zealand maintains the ability to perform specialist radiation oncology treatments.

Future plans

Over half (55%) of the current workforce reported an intention to retire within 15 years. This compares to around 46% for the Australian data.² This is clearly an area of concern. Membership data indicate that, between 2013 and 2018, 12 new fellows

graduated the training programme.⁸ Should this rate continue without increase, it will be insufficient to make up for losses through retirement and reduction of hours, let alone allow any growth in capacity.

Radiation oncology trainees

Radiation oncology trainees all reported working full time; however, 40% wanted to be able to work part time. Overtime workload was significant, with half of the trainees reporting 6–10 hours overtime per week and only half having time to pursue interests outside of work. Although most report an interest in oncology as the driver for career choice, almost three-quarters chose the career as it offered a lifestyle they wanted, and 55.6% chose radiation oncology as it was “family friendly”.

We need to be mindful that, although they were a committed group, the trainees make clear that lifestyle and outside of work are priorities and overwork is likely to be destructive to morale and potentially to retention. In a specialty dependent on sustained growth in numbers of new fellows, it is concerning that one-third of trainee respondents reported intending to leave the specialty and two-thirds had concerns with balancing responsibilities. These findings are consistent with reports of a 2012 trainee survey by the RANZCR. In this survey, trainees across Australia and New Zealand indicated lifestyle was an important reason for choosing radiation oncology as a career, and only 40% in this survey had time to pursue interests outside of work.¹⁴

The quality of training is also important in securing the future of the speciality. Trainees report a relatively low training versus service time. Contouring time was less than five hours a week for 83%, and protected time for teaching for the majority was less than two hours per week. Limited time in planning is not unique to New Zealand, with 60% of USA residents reporting insufficient exposure to treatment planning.^{13,15}

Retention in New Zealand after gaining the fellowship may be influenced by the fact that the majority of trainees wish to have an academic component to their career, but opportunities for this with current fellow staffing levels are low. It was interesting that 42% of radiation oncology

respondents embarked on a fellowship post after obtaining the Fellowship of the Australian and New Zealand College of Radiologists (FRANZCR), the majority being undertaken overseas. Limited fellowship opportunities exist in New Zealand. The international fellowship has much to offer, with experience brought back to New Zealand. However, not all trainees are able to move overseas, and hence this decreases employment opportunities, and historical figures reveal some never return to New Zealand after an overseas fellowship, with a further loss of potential workforce.⁸ The development of fellowship positions within New Zealand has been identified by the RANZCR as a priority, but funding these remains challenging.

The future of the specialty is reliant on training registrars to become skilled and engaged radiation oncologists. Recruitment may be increased by the option of part time training, adequate job sizing, more flexible rotation programs and accreditation programs ensuring adequate protected training time. Investment in training increased numbers of registrars is urgently required.

Current initiatives

The New Zealand National Radiation Oncology Plan predicted that a further 28 oncologists would be required between 2017 and 2021 to maintain current demand for radiation services. This plan acknowledged that this prediction was based on current workloads and that “if overtime is used extensively now, then that would continue into the future”.¹⁶ This projection also did not take into account loss from the work-

force due to part-time work or retirement, or did it allow for an increase in capacity to potentially improve the current low proportion of patients in New Zealand who receive radiation. This intervention rate is 37.4%,¹⁶ well below the 48%–52% recommended in the literature.¹

The RANZCR has identified a need to increase recruitment and retention and has been exploring initiatives. Cancer workforce has also been identified in the Ministry of Health cancer plan as a priority focus area, as has the need to grow the Māori and Pacific workforce.¹⁷

Conclusion

The radiation oncology workforce in New Zealand is small, with minimal growth in staffing numbers in recent years. The workforce continues to be reliant on radiation oncologists trained overseas, who comprise a third of current fellow numbers. The workforce has an older demographic with a high rate of intention to retire in the next decade. Overtime work is significant and contracted hours do not routinely allow for time in research and other non-clinical duties. Trainee numbers do not seem sufficient to meet the potential demand for replacements due to decreasing hours and retirements. There is some evidence that work conditions may not be well adjusted to the priorities of the trainees, and this may adversely affect retention. Workforce planning is vital and must include consideration of modern radiation work components, diversity and skill mix. These factors must be not only considered but addressed, to ensure a viable radiation oncology workforce for the future.

Competing interests:

Nil.

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REFERENCES:

1. Leung J, Fostner D, Chee R et al. Faculty of Radiation Oncology 2018 workforce census. *J Med Imaging Radiat Oncol.* 2019; 63: 852-861
2. James ML, Munro PL, Leung J. Faculty of Radiation Oncology 2014 Workforce Census: a comparison of New Zealand and Australian responses. *N Z Med J.* 2015 Apr 17;128:39-46.
3. Barton MB, Jacob S, Shafiq J et al. Estimating the demand for radiotherapy from the evidence: a review of changes from 2003 to 2012. *Radiother Oncol.* 2014;112:140-4.
4. Fung CY, Chen E, Vapiwala N, Pohar S, Trifiletti D et al. The American Society for Radiation Oncology 2017 Radiation Oncologist Workforce Study. *Int J Radiat Oncol Biol Phys.* 2019 Mar 1;103(3):547-556. doi: 10.1016/j.ijrobp.2018.10.020
5. Loewen SK, Doll CM, Halperin R et al. National Trends and Dynamic Responses in the Canadian Radiation Oncology Workforce From 1990 to 2018. *International Journal of Radiation Oncology, Biology and physics* 2019; 105:31-41
6. The New Zealand Medical Workforce in 2018. <https://www.mcnz.org.nz/assets/Publications/Workforce-Survey/434ee633ba/Workforce-Survey-Report-2018.pdf> Accessed 23/2/2020 at 5:28 pm
7. Results of the ASMS salary survey of Senior medical and dental officers October 2018. https://www.asms.org.nz/wp-content/uploads/2019/01/Salary-Survey-Report-2018_170613.2.pdf. Accessed 23 2 2020 at 5:26pm.
8. RANZCR Trainee Information Management System as at 31/06/2018
9. Downing A, Morris EJA, Corrigan N et al. High hospital research participation and improved colorectal cancer survival outcomes: a population-based study. *Gut.* 2017; 66: 89-96
10. Oncology and Haematology National Research Strategy Process Document. Personal communication.
11. Research for All. Royal College of Physicians March 2016. <https://www.rcplondon.ac.uk/projects/outputs/research-all>. Accessed 23 2 2020 at 6:37 pm.
12. Vorwerk H, Zink K, Schiller R et al. Protection of quality and innovation in radiation oncology: The prospective multi-

- center trial the German Society of Radiation Oncology (DEGRO-QUIRO study). *Strahlentherapie und Onkologie* 2014; 190: 433-443
13. Leung, J. and Lehman, M. Contouring experiences amongst Australian, New Zealand and Singaporean radiation oncology trainees. Is it enough? What next? *J Med Imaging Radiat Oncol.* 2019; 63 :383-389.
 14. Leung, J., Le, H., Turner, S., Munro et al. FRO 2012 trainee survey. *Journal of Medical Imaging and Radiation Oncology.* 2014; 58:125-133.
 15. Wu S, Sath C, Schuster J et al. Targeted Needs Assessment of Treatment Planning Education for United States Radiation Oncology Residents. *IJROBP* 2020; 106: 677-682
 16. Ministry of Health. 2017. The National Radiation Oncology Plan 2017-2021. Wellington, New Zealand: Ministry of Health
 17. Ministry of Health. 2019. New Zealand Cancer Action Plan 2019-2029 – Te Mahere mō te Mate Pukupuku o Aotearoa 2019-2029. Revised January 2020 Wellington: Ministry of Health.