

Survey of brachytherapy training experience among radiation oncology trainees and fellows in the Royal Australian and New Zealand College of Radiologists (RANZCR)

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Abstract

Introduction: To evaluate brachytherapy training experience among trainees and fellows trained through the Royal Australian and New Zealand College of Radiologists (RANZCR).

Methods: All current trainees and fellows (who obtained fellowship from 2015 onwards) were sent an online anonymous questionnaire on various aspects of brachytherapy training, including number of cases observed/ performed, opinions on brachytherapy assessment during training, barriers to brachytherapy training and future role of brachytherapy.

Results: The overall survey response rate was 24% (40/161 trainees, 30/126 fellows). Of the 70 respondents, 50 (71%), 38 (54%) and 43 (61%) reported to have received formal brachytherapy teaching from radiation oncologists, radiation therapists and medical physicists respectively. Most respondents had exposure to *gynaecology* brachytherapy – two-thirds of trainees and all fellows have performed at least one gynaecology brachytherapy procedure. *Prostate* brachytherapy exposure was more limited – by the end of training, 27% and 13% of fellows did not have exposure to LDR and HDR prostate brachytherapy. More than two-thirds indicated there should be a minimum number of brachytherapy case requirements during training, and half indicated that trainees should be involved in ≥ 6 gynaecology brachytherapy procedures. Barriers affecting training include lack of caseload (70%) and perceived decreasing role of brachytherapy (66%). Forty-three percent of respondents were concerned about the decline in brachytherapy utilisation.

Conclusion: This is the first survey on brachytherapy training experience among RANZCR trainees and fellows. It highlighted limited brachytherapy exposure during RANZCR training, and the need to revisit brachytherapy training requirement in the current training programme, along with long-term brachytherapy workforce planning.

Key words: brachytherapy; education; survey; training.

Introduction

Brachytherapy is an integral component of radiation therapy for various cancers, in particular for prostate cancers and gynaecological cancers, such as endometrial and cervix cancer.¹ However, population-based studies have shown that there has been a decline in brachytherapy utilisation in cervical cancers,^{2,3} and prostate cancers^{4–7} over the years. This decline in brachytherapy utilisation may have far-reaching consequences beyond current patient care – it will also impact on radiation oncology (RO) training, and in the longer term may translate into a shortfall of radiation oncologists proficient in brachytherapy. In a review of the United States (US) RO trainees' case logs from 2006 to 2011, Compton *et al.* reported the average number of interstitial brachytherapy procedures performed by the US trainees had decreased by 25% over the 5-year period, and the author suggested that one of the reasons is due to decline in brachytherapy utilisation.⁸

Brachytherapy training requirements vary across different countries and healthcare systems. In the US, the Accreditation Council of Graduate Medical Education (ACGME) mandates that RO trainees are required to perform at least seven interstitial and 15 intracavitary brachytherapy implants prior to completing their training.⁹ In the United Kingdom, the Royal College of Radiologist (RCR) Clinical Oncology training does not stipulate a minimum number of brachytherapy procedures required, and brachytherapy training is considered a post-fellowship advanced skill.¹⁰ Similarly, in The Royal College of Physicians and Surgeons of Canada (RCPSC) RO training program, there is no minimum number of brachytherapy cases mandated during training. However, trainees are expected to be able to perform intracavitary gynaecology brachytherapy at the completion of training.¹¹ There is an option for a further 12 months of brachytherapy training through the RCPSC Brachytherapy Area of Focused Competence (AFC).^{11,12}

In the current Royal Australian and New Zealand College of Radiologists (RANZCR) RO training programme, there is also no stipulation of a minimum number of brachytherapy cases that each trainee has to perform, apart from completing one case report each on prostate brachytherapy and gynaecology brachytherapy.^{13,14} While there is no published literature on the brachytherapy training experience in RANZCR training programme, anecdotal experiences suggest that there is lack of adequate exposure to brachytherapy among RANZCR trainees, and the number of brachytherapy cases performed by RANZCR trainees is significantly lower compared to overseas trainees.^{8,15,16} In this study, we aim to evaluate the brachytherapy training experience among RO trainees within the RANZCR training programme over the last 10 years.

Methods

Study population

This is a cross-sectional anonymised survey among RANZCR accredited trainees and junior fellows, across Australia, New Zealand and Singapore. We included fellows who have obtained their fellowship from 2015 onwards, in order for the survey to be reflective of a more contemporary RO training experience within the last 10 years.

Survey

The survey was adapted from a recent survey conducted by the US Association of Residents in Radiation Oncology (ARRO),¹⁵ and tailored to the structure of RANZCR training programme. The survey comprised 15 questions with multiple choice or Likert scale answers, and options for additional text comments (Appendix A). There were five main components within the questionnaire: (i) brachytherapy training experience, including number of brachytherapy cases observed and performed, (ii) opinions regarding the assessment of brachytherapy competency in the current RANZCR training programme, (iii) brachytherapy competency at the end of training, and intended post-fellowship brachytherapy training (if any), (iv) perceived barriers to brachytherapy training, and (v) opinion regarding the future role of brachytherapy. The survey questions were trialled for comprehension and appropriateness by the 2020 and 2021 RANZCR Radiation Oncology Trainee Committee (ROTC) prior to activation.

Survey distribution

The survey was hosted on the Qualtrics platform, and an electronic link to the survey was distributed via RANZCR to 161 accredited trainees (including those currently on training break), and 126 fellows who have obtained RANZCR fellowship from 1 January 2015 onwards. The survey was open from 28 July 2021 to 1 October 2021. A reminder email was sent out 1 week prior to closing of the survey. In addition, the survey was also distributed via ROTC to trainees in their respective training network, and through the Australasian Brachytherapy Group (ABG). The study was approved by the Monash University Human Research Ethics Committee.

Statistical analyses

Anonymised raw data were downloaded from the Qualtrics platform on closing date of the survey. Survey responses with more than 80% missing data were excluded from analysis. Descriptive statistics were used to analyse the results.

Results

A total of 70 responses from 287 eligible trainees and fellows were available for analysis, with an overall response rate of 24% – 40/161 (25%) trainees and 30/126 (24%) fellows. Of the respondents, 15 (21%) were from Victoria/Tasmania training network, 12 (17%) from New South Wales (North), 6 (9%) New South Wales (South), 10 (14%) Queensland, 2 (3%) Western Australia, 4 (6%) South Australia/Northern Territory, 12 (17%) New Zealand, 1 (1%) Singapore, and 8 (11%) were trainees/fellows who trained across more than one training networks.

Brachytherapy training experience

Of all 70 respondents (including trainees and fellows), 50 (71%), 38 (54%) and 43 (61%) agreed or strongly agreed that they have received formal teaching in brachytherapy from radiation oncologists, radiation therapists and medical physicists respectively.

Half of the trainees agreed or strongly agreed that they received adequate gynaecological brachytherapy training – vaginal vault brachytherapy for endometrial cancer (60%) and intracavitary brachytherapy for cervix cancer (45%) (Table 1). However, only 15% agreed that they received adequate training for LDR prostate brachytherapy. A significant majority of trainees reported to have not received training in brachytherapy for breast cancer (85%), soft tissue tumour (84%) and skin cancer (70%), which were not mandatory requirements within the current radiation oncology curriculum.

When asked about the number of brachytherapy cases observed or performed, gynaecological brachytherapy was the site where trainees and fellows had most exposure (Table 2). There were 75% (30/40) and 68% (27/40) current trainees (across different training years) who have *observed* at least one case of vaginal vault brachytherapy and intracavitary cervical brachytherapy, respectively, while 68% (27/40) and 63% (25/40) have *performed* at least one vaginal vault brachytherapy and

Table 1. Adequate[†] brachytherapy training (among current radiation oncology trainees, *n* = 40)

	Strongly agree	Agree	Neither agree/disagree	Disagree	Strongly disagree
Prostate cancer LDR	0 (0%)	6 (15%)	7 (18%)	12 (30%)	15 (38%)
Prostate cancer HDR	5 (13%)	12 (30%)	6 (15%)	11 (28%)	6 (15%)
Cervical cancer (intracavitary)	8 (20%)	10 (25%)	7 (18%)	8 (20%)	7 (18%)
Cervical cancer (interstitial/ hybrid)	5 (13%)	7 (18%)	8 (20%)	10 (25%)	10 (25%)
Endometrial cancer (vaginal vault)	8 (20%)	16 (40%)	4 (10%)	6 (15%)	6 (15%)
Breast cancer	0 (0%)	1 (3%)	5 (13%)	10 (25%)	24 (60%)
Skin cancer	2 (5%)	3 (8%)	7 (18%)	10 (25%)	18 (45%)
Soft tissue cancer	1 (3%)	1 (3%)	4 (10%)	11 (28%)	23 (56%)

[†]Adequate such that I will be comfortable performing applicator insertion independently and reviewing/ approving brachytherapy treatment plan at the of my training.

Table 2. Number of brachytherapy cases observed and performed during RANZCR radiation oncology training (*n* = 70)

		Trainees (<i>n</i> = 40)				Fellows (<i>n</i> = 30)			
		0	1–5	6–10	>10	0	1–5	6–10	>10
Prostate cancer LDR	Observed	29 (73%)	8 (20%)	3 (8%)	0 (0%)	8 (27%)	19 (63%)	2 (7%)	1 (3%)
	Performed	32 (80%)	6 (15%)	1 (3%)	1 (3%)	18 (60%)	10 (33%)	1 (3%)	1 (3%)
Prostate cancer HDR	Observed	16 (40%)	11 (28%)	9 (23%)	4 (10%)	4 (13%)	15 (50%)	5 (17%)	6 (20%)
	Performed	18 (45%)	13 (33%)	5 (13%)	4 (10%)	12 (40%)	11 (37%)	2 (7%)	5 (17%)
Cervical cancer (intracavitary)	Observed	13 (33%)	9 (23%)	5 (13%)	13 (33%)	1 (3%)	5 (17%)	6 (20%)	18 (60%)
	Performed	15 (38%)	11 (28%)	3 (8%)	11 (28%)	1 (3%)	11 (37%)	7 (23%)	11 (37%)
Cervical cancer (interstitial/ hybrid) [†]	Observed	18 (45%)	13 (33%)	5 (13%)	4 (10%)	6 (20%)	16 (53%)	2 (7%)	5 (17%)
	Performed	23 (58%)	12 (30%)	2 (5%)	3 (8%)	13 (43%)	11 (37%)	2 (7%)	4 (13%)
Endometrial cancer (vaginal vault)	Observed	10 (25%)	11 (28%)	5 (13%)	14 (35%)	0 (0%)	3 (10%)	6 (20%)	21 (70%)
	Performed	13 (33%)	11 (28%)	7 (18%)	9 (23%)	0 (0%)	8 (27%)	9 (30%)	13 (43%)
Breast cancer	Observed	37 (93%)	2 (5%)	0 (0%)	1 (3%)	26 (87%)	3 (10%)	0 (0%)	1 (3%)
	Performed	37 (93%)	2 (5%)	0 (0%)	1 (3%)	27 (90%)	2 (7%)	0 (0%)	1 (3%)
Skin cancer	Observed	31 (78%)	6 (15%)	3 (8%)	0 (0%)	21 (70%)	8 (27%)	0 (0%)	1 (3%)
	Performed	34 (85%)	6 (16%)	0 (0%)	0 (0%)	27 (90%)	2 (7%)	1 (3%)	0 (0%)
Soft tissue cancer	Observed	38 (95%)	2 (5%)	0 (0%)	0 (0%)	25 (83%)	5 (17%)	0 (0%)	0 (0%)
	Performed	38 (95%)	2 (5%)	0 (0%)	0 (0%)	29 (97%)	1 (3%)	0 (0%)	0 (0%)

[†]1 missing response from fellow on observed cases on cervix cancer interstitial/ hybrid brachytherapy.

intracavitary cervical brachytherapy respectively. All 30 fellows have *performed* at least one vaginal vault brachytherapy procedure – 30% (9/30) and 43% (13/30) had performed 6–10 and >10 vaginal vault brachytherapy procedures, respectively, during their training.

Exposure to brachytherapy for prostate cancer, however, was more limited (Table 2). Of the current trainees, only 28% (11/40) and 60% (24/40) have *observed* at least one case of LDR and HDR brachytherapy for prostate cancer, respectively, while 20% (8/40) and 55% (22/40) have *performed* at least one case of LDR and HDR brachytherapy for prostate cancer respectively. Among fellows, 73% (22/30) and 87% (26/30) have observed at least one case of LDR and HDR brachytherapy for prostate cancer, respectively, while 40% (12/30) and 60% (18/30) have performed at least one case of LDR and HDR brachytherapy for prostate cancer respectively. At the other end of the spectrum, there were 17% (5/30) fellows who have performed >10 HDR brachytherapy procedures for prostate cancer during their training.

Brachytherapy assessment during training

There were split opinions regarding adequacy of brachytherapy training requirements within the current RANZCR curriculum (Table 3). For *gynaecological brachytherapy*, 35% (24/69) agreed or strongly agreed that the minimum of one case report was adequate, while 36% (25/69) disagreed or strongly disagreed

(remaining 29% (20/69) neither agreed nor disagreed). For *prostate brachytherapy*, 29% (20/70) agreed or strongly agreed that the minimum of one case report was adequate, while 44% (31/70) disagreed or strongly disagreed. Overall, only 21% (15/70) respondents indicated that brachytherapy competency was adequately assessed in the current training programme (Table 3).

More than two-thirds (48/70) agreed/ strongly agreed that there should be a minimum number of brachytherapy cases that trainees should be involved in during training. However, opinions on the minimum number of cases varied for different tumour sites (Table 3). For intracavitary brachytherapy for cervix cancer and vaginal vault brachytherapy, approximately half of respondents – 51% (35/68) and 48% (32/67) respectively – indicated that trainees should be involved in ≥6 cases. For prostate brachytherapy, 30% (20/67) and 38% (26/68) indicated that trainees should be involved in ≥6 cases of LDR and HDR brachytherapy respectively. Approximately half of respondents indicated that there is no need for a minimum number of cases for less common tumour sites such as breast and soft tissue tumours during training.

Brachytherapy competency after training and post-fellowship plan

Of the fellows who have completed training, a large majority were not comfortable performing brachytherapy independently for all tumour sites, except for vaginal

Table 3. Opinions on current brachytherapy assessment, and recommended minimum number of brachytherapy cases that trainees should be involved in during RANZCR radiation oncology training (*n* = 70)

	Strongly agree	Agree	Neither agree/ disagree	Disagree	Strongly disagree
The minimum requirement to complete one prostate brachytherapy case report is adequate	7 (10%)	13 (19%)	19 (27%)	24 (34%)	7 (10%)
The minimum requirement to complete one gynaecology brachytherapy case report is adequate [†]	10 (14%)	14 (20%)	20 (29%)	18 (26%)	7 (10%)
My brachytherapy competency is adequately assessed in RANZCR radiation oncology training	3 (4%)	12 (17%)	25 (36%)	21 (30%)	9 (13%)
There should be minimum number of brachytherapy cases observed/ performed during radiation oncology training	13 (19%)	35 (50%)	13 (20%)	7 (10%)	1 (1%)
Recommended minimum number of cases	0	1–5	6–10	11–20	>20
Prostate cancer LDR [‡]	7 (10%)	40 (60%)	15 (22%)	5 (7%)	0 (0%)
Prostate cancer HDR [§]	5 (7%)	37 (54%)	17 (25%)	7 (10%)	2 (3%)
Cervical cancer (intracavitary) [§]	4 (6%)	29 (43%)	22 (32%)	9 (13%)	4 (6%)
Cervical cancer (interstitial/ hybrid) [‡]	6 (9%)	39 (58%)	13 (19%)	7 (10%)	2 (3%)
Endometrial cancer (vaginal vault) [‡]	4 (6%)	31 (46%)	18 (27%)	10 (15%)	4 (6%)
Breast cancer [¶]	30 (45%)	27 (41%)	7 (11%)	2 (3%)	0 (0%)
Skin cancer [§]	27 (40%)	32 (47%)	8 (12%)	1 (1%)	0 (0%)
Soft tissue cancer [§]	33 (49%)	29 (43%)	5 (7%)	1 (1%)	0 (0%)

†1 missing response.

§2 missing responses.

‡3 missing responses.

¶4 missing responses.

Table 4. Brachytherapy competency after completion of RANZCR radiation oncology training (among fellows, $n = 29$)

Comfortable performing brachytherapy independently	Strongly agree	Agree	Neither agree/disagree	Disagree	Strongly disagree
Prostate cancer LDR	0 (0%)	2 (7%)	0 (0%)	13 (45%)	14 (48%)
Prostate cancer HDR	1 (3%)	2 (7%)	1 (3%)	17 (59%)	8 (28%)
Cervical cancer (intracavitary)	2 (7%)	7 (24%)	7 (24%)	9 (31%)	4 (14%)
Cervical cancer (interstitial/ hybrid)	2 (7%)	5 (17%)	2 (7%)	9 (31%)	11 (38%)
Endometrial cancer (vaginal vault)	3 (10%)	11 (38%)	7 (24%)	4 (14%)	4 (14%)
Breast cancer	0 (0%)	1 (3%)	0 (0%)	9 (31%)	19 (66%)
Skin cancer	2 (7%)	2 (7%)	1 (3%)	6 (21%)	18 (62%)
Soft tissue cancer	0 (0%)	2 (7%)	0 (0%)	8 (28%)	19 (66%)

Table 5. Options to improve brachytherapy competency among trainees/fellows who foresee themselves performing brachytherapy in future clinical practice ($n = 42$)

	Highly likely	Likely	Neither likely/unlikely	Unlikely	Highly unlikely
Local fellowship	2 (5%)	13 (31%)	15 (36%)	12 (29%)	0 (0%)
Overseas fellowship	4 (10%)	6 (14%)	17 (41%)	12 (29%)	3 (7%)
Observership	7 (17%)	13 (31%)	16 (38%)	6 (14%)	0 (0%)
ABG workshop	7 (17%)	18 (43%)	14 (33%)	3 (7%)	0 (0%)
Other courses	4 (10%)	21 (50%)	13 (31%)	4 (10%)	0 (0%)
On the job training†	13 (33%)	15 (36%)	11 (26%)	2 (5%)	0 (0%)

†1 missing response.

Table 6. Perceived barriers affecting brachytherapy training in the current RANZCR radiation oncology training programme ($n = 70$)

	Strongly agree	Agree	Neither agree/disagree	Disagree	Strongly disagree
Lack of number of cases	14 (20%)	35 (50%)	9 (13%)	11 (16%)	1 (1%)
Lack of formal teaching	8 (11%)	22 (31%)	27 (39%)	13 (19%)	0 (0%)
Decreasing role of brachytherapy	12 (17%)	34 (49%)	14 (20%)	9 (13%)	1 (1%)
Personal lack of interest	1 (1%)	20 (29%)	28 (40%)	16 (23%)	5 (7%)
Low level of competency requirement to obtain FRANZCR	9 (13%)	20 (29%)	25 (36%)	14 (20%)	2 (3%)

vault brachytherapy, whereby approximately half of the fellows (14/29) agreed or strongly agreed to be comfortable performing vaginal vault brachytherapy independently (Table 4). For prostate brachytherapy, only 7% (2/29) and 10% (3/29) fellows agreed or strongly agreed to be comfortable performing LDR and HDR brachytherapy, respectively, at the end of training.

Table 7. Role of brachytherapy in the next 10 years for the following tumour sites ($n = 70$)

	Increasing role	No change	Decreasing role
Prostate cancer	9 (13%)	29 (41%)	32 (46%)
Cervical cancer	8 (11%)	54 (77%)	8 (11%)
Endometrial cancer	10 (14%)	59 (84%)	1 (1%)
Breast cancer	6 (9%)	15 (21%)	49 (70%)
Skin cancer	8 (11%)	32 (46%)	30 (43%)
Soft tissue cancer	6 (9%)	35 (50%)	29 (41%)

There were 42 (60%) respondents – 30 (75%) trainees and 12 (40%) fellows – who foresee themselves performing brachytherapy as part of future clinical practice (yes, or maybe). Of these, the likely options to further improve brachytherapy competencies after RANZCR training programme included on-the-job training (69%), and attending courses such as the ABG Clinical Brachytherapy Workshop (50%) (Table 5). There were 26% and 24% of respondents who would consider local and overseas brachytherapy fellowship respectively.

Barriers to brachytherapy training

Most respondents agreed or strongly agreed that the main barriers to brachytherapy training were the lack of number of cases (70%), perceived decreasing role of brachytherapy (66%), low level of competency requirement to complete RANZCR training (42%), and lack of formal teaching (42%) (Table 6). Other barriers raised included: lack of protected time for trainees to participate in brachytherapy procedures, no access to brachytherapy in all training centres, lack of support to establish a brachytherapy programme (given the lack of financial incentive for brachytherapy), and perceived lack of evidence of superiority of brachytherapy over external beam radiation therapy, for example, in prostate cancer (Appendix B).

Future role of brachytherapy

Overall, only 43% (30/70) respondents believed that the declining utilisation of brachytherapy is concerning. The majority of respondents believed that the future role of

brachytherapy in cervical cancer and endometrial cancer will increase or stay about the same in the next 10 years (Table 7). However, almost half of the respondents felt that there will be decreasing role of brachytherapy in prostate cancer over the next 10 years.

Discussion

To our knowledge, this is the first survey on brachytherapy training experience among RANZCR RO trainees and fellows. The survey indicated that there is lack of exposure, lack of trainees' participation, and lack of mandatory training requirements for brachytherapy in the current RANZCR training programme. It also highlighted several barriers to brachytherapy training including low caseload, trainees perceived decreasing role of brachytherapy, lack of formal teaching and low level of brachytherapy competency requirements to complete training.

This is the first time that the *lack of exposure* to brachytherapy during RANZCR training has been reported, based on self-reported numbers of brachytherapy cases observed or performed by trainees and fellows. Given that there is no requirement for a minimum case number in the RANZCR training, or the need to maintain a case log for brachytherapy procedures observed or performed, these numbers are subject to recall biases and we could not discount either over- or under-reporting of the number of cases. Overall, these numbers are still markedly lower than that reported by trainees in the US training programme.¹⁷ A review of case logs of US trainees who completed training between 2007 and 2018 showed that the average number of gynaecological intracavitary brachytherapy procedures performed per trainee was 40 in 2007, and this increased to 48 in 2018.¹⁷ This is in contrast to the RANZCR fellows, whereby more than half had performed <10 cases of gynaecological intracavitary brachytherapy (Table 2). The average number of prostate brachytherapy procedures performed was 22 per US trainee in 2007, and this decreased to 12 per US trainee in 2018.¹⁷ Again, this is in contrast to the RANZCR fellows with approximately one-quarter having not observed, and half having not performed prostate brachytherapy by the end of their training (Table 2).

The *lack of minimum brachytherapy case requirements* to complete the RANZCR training programme was also highlighted, whereby trainees only need to complete one case report each on prostate brachytherapy and gynaecological brachytherapy.^{13,14} Like any other procedural skills, there is a learning curve to achieve competency in brachytherapy.^{18–20} In the recent survey by the US-based ARRO among RO trainees in 2017, the US trainees were of the opinion that the minimum training requirement to have performed 15 cases of intracavitary brachytherapy was deemed adequate, while the minimum requirement of five cases for interstitial

brachytherapy (at that time) was deemed inadequate.¹⁵ Since then the US ACGME has increased the minimum requirement for interstitial brachytherapy to seven cases per trainee in 2020.⁹ When making comparisons in brachytherapy case requirements between RO training programmes in different countries, it is important to be aware of the differences in the expectations for independent brachytherapy practice at the end of training. In the US, most graduating trainees are expected to transition into independent brachytherapy practice at the end of training; hence the need for higher caseloads during training in order to achieve brachytherapy competency.

In the Canadian training programme (which is more comparable to that of the RANZCR training programme), there is an expectation for Canadian trainees 'to be competent to determine when brachytherapy is the most appropriate treatment, to prescribe and supervise brachytherapy treatment for prostate, endometrial, and cervical cancer, and to perform intracavitary brachytherapy for cervical cancer at the end of training'.¹¹ In the current survey, only one-third of RANZCR junior fellows are comfortable performing intracavitary brachytherapy for cervical cancer at the end of their training (Table 4). In order for RANZCR trainees to achieve competency and independence to perform intracavitary gynaecological brachytherapy at the end of their training (e.g. as expected in the Canadian training programme), indeed there may be a need to stipulate a minimum number of cases that trainees are involved in during training, with case logs to document the number of cases performed. In fact, more than two-thirds of the survey respondents agreed or strongly agreed that there should also be a requirement for a minimum number of brachytherapy cases observed or performed during training, and approximately half of the survey respondents felt that trainees should be involved in ≥ 6 intra-cavitary cervix brachytherapy and vaginal vault brachytherapy (Table 4).

There are multiple barriers affecting brachytherapy training identified in the survey. One that has been consistently reported in the literature, and highlighted again in the current survey, is the *lack of brachytherapy caseload* due to declining brachytherapy utilisation.²¹ This trend may prove to be self-reinforcing, whereby the reduction in brachytherapy caseload leads to fewer radiation oncologists proficient in brachytherapy, and further reduction in brachytherapy utilisation. To overcome this, some US training centres have instituted brachytherapy simulation-based workshops to compensate for the reduced caseload, which have resulted in improvement in knowledge and technical proficiency among trainees.^{22,23} This simulation-based training has also been adapted in other international centres.²⁴ While similar ABG brachytherapy workshops with practical sessions have been conducted, it is unclear as to the impact on trainees' overall brachytherapy training experience and competencies. These workshops alone, however, will not

be sufficient for trainees to achieve competencies for independent brachytherapy practice, but it is hoped that it may stimulate trainees' interest to seek out further 'hands-on' brachytherapy training.

The *perceived decreasing role of brachytherapy* is also a reported barrier affecting brachytherapy training. There may be multiple factors adding to the misconception and 'devaluing' of brachytherapy in our practice, for example, perception that dose intensification can be achieved through 'virtual brachytherapy' using stereotactic radiation therapy, or influence by radiation oncologists who do not practice brachytherapy. This general negative misconception regarding brachytherapy is also reflected in the survey respondents' opinion on the brachytherapy utilisation, with more than half not feeling concerned about the declining brachytherapy utilisation. Also, in contrast to 78% of US trainees who felt that the role of brachytherapy for prostate cancer will increase or stay about the same for the next 10 years,¹⁵ almost half of current survey respondents (46%) felt that there will be a decreasing role of brachytherapy for prostate cancer.

Forty-two percent of respondents believed that the *low level of competency requirements* and *lack of formal teaching* within the current RANZCR training programme are also barriers affecting brachytherapy training (Table 4). The overall lack of emphasis on brachytherapy in the training programme may give trainees the impression that brachytherapy is not a treatment modality highly valued by RANZCR and hence limit their motivation to achieve brachytherapy competency at the end of training. It may also cause trainees to not consider pursuing brachytherapy as part of future clinical practice. While we acknowledge that not all trainees or fellows are expected to go on to perform brachytherapy as part of their future clinical practice for varying reasons, it is crucial that trainees are well-educated on the due merits and indications for brachytherapy (including in more specialised areas, for example, interstitial brachytherapy for cervical cancer, and less common clinical scenarios, for example, skin cancer and soft tissue cancers) through formal evidence-based didactic teaching. Newly qualified radiation oncologists need to come out of RANZCR training well-informed of the role of brachytherapy, and at least be competent in recognising when appropriate referral to colleagues or centres that perform brachytherapy is indicated, even if they do not perform brachytherapy in their own clinical practice.

Multiple survey respondents also reported that brachytherapy services were not available at their training sites (Appendix B). It is important to recognise that brachytherapy services are often centralised due to high resource need, and it is not feasible to offer brachytherapy in every radiation oncology department. One potential approach to overcome the lack of access to brachytherapy training opportunity for trainees is to adopt one of the American Brachytherapy Society '300-in-10' initiatives by offering a 2-month 'hands-on'

elective fellowship for senior trainees to spend time at certified brachytherapy centres.²⁵ However, this arrangement will require engagement between RANZCR and brachytherapy centres, with clear guidelines for brachytherapy centres to be accredited for this purpose, and to have this 2-month dedicated brachytherapy training period accredited towards the trainees overall training time. Another approach to consider is to adopt the Canadian diploma certification programme,¹¹ whereby trainees who have passed their fellowship examinations, can spend a further 12 months in an accredited brachytherapy programme in certified brachytherapy centres, leading to the award of a RANZCR-accredited diploma in brachytherapy.

One of the limitations of the survey is the low survey response rate of 24%, which may not be generalised to the experience of all RANZCR trainees or fellows. This is in contrast to higher response rates in previously published RANZCR trainee surveys, ranging from more than 80% for the RANZCR-initiated trainee burnout survey,²⁶ to more than 50% for the survey on trainees' knowledge and attitudes regarding geriatric oncology,²⁷ and 40–70% for surveys on trainee research requirements.^{28,29} Despite all the surveys being opened for similar durations, the varying survey response rates are often dependent on the general interest in the topic of the survey. The low response rate in the current survey is possibly reflective of the general low level of engagement, and lack of interest, in brachytherapy among trainees and fellows. It may also depend on the frequency of reminder emails for survey participation, whereby the RANZCR-initiated survey with survey responses of more than 80% involved weekly email reminders for the duration of survey,²⁶ whereas the current survey only involved one email reminder 1 week prior to closure of the survey. A potential implication of the low survey response rate is that decision-making stakeholders (e.g. RANZCR) may not find relevance in the survey results to initiate changes to improve brachytherapy training given that it may be deemed not representative of the voices of the majority of trainees or fellows. However, the survey response rate in our cohort is similar to the brachytherapy surveys conducted among Canadian trainees (22%) and fellows (24%).¹⁶ Also, the heterogeneity of trainee respondents, which range from first year to final year trainees limited our interpretation of current trainees' experience, as some trainees may not have had brachytherapy exposure early on in their training – the overall low number of trainee respondents has limited our analyses by year of training. There were only 12 (17%), and 1 (1%), respondents from New Zealand and Singapore, respectively, and it is not possible to make comparisons of brachytherapy training between different countries.

In conclusion, this survey assesses, for the first time, the state of play of brachytherapy training in the current RANZCR training programme, with important implications for our clinical specialty. The survey findings highlight the need to increase engagement with RANZCR to revisit the current brachytherapy training in the

curriculum, including the content, relevance, training, and assessment requirements. Equally important is to evaluate the long-term brachytherapy workforce requirement and design strategic programmes, to ensure an ongoing supply of radiation oncologists competent in performing brachytherapy in the region.

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Data availability statement

Data available on request from the authors

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Appendix A

Questionnaires

Question 1

Are you currently in RANZCR accredited training, or have you obtained your FRANZCR fellowship?

Current RANZCR accredited trainee	<1	1–2	2–3	3–4	4–5	5+	
Current year of training (for trainees)							N/A
Fellow (who has obtained FRANZCR fellowship)	2015	2016	2017	2018	2019	2020	2021
Which year did you obtain your FRANZCR fellowship (for fellow)							

Question 2

Which Training Network are you undertaking (or have you undertaken) your training? (multiple selections allowed if trained across different network).

	NSW-Northern	NSW-Southern	VIC/TAS	QLD	SA/NT	WA	NZ	Singapore
Training network								

Question 3 | DURING TRAINING

I have received adequate training*, including didactic teaching and/ or tutorial, in brachytherapy for the following disease sites during my RANZCR Radiation Oncology Training program.

*adequate training such that I will be/ am comfortable performing brachytherapy applicator insertion, and reviewing brachytherapy treatment plan at the end of my RANZCR Radiation Oncology Training Program.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Definitive prostate cancer (LDR brachytherapy)					
Definitive prostate cancer (HDR brachytherapy)					
Definitive cervical cancer (intracavitary)					
Definitive cervical cancer (hybrid or interstitial)					
Adjuvant endometrial cancer (vaginal vault)					
Adjuvant breast cancer (interstitial)					
Skin cancer (applicator)					
Soft tissue cancer (interstitial)					

Question 4 | DURING TRAINING

I have received formal teaching in brachytherapy from the following craft groups during my RANZCR Radiation Oncology Training Programme:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Radiation oncologist					
Radiation therapist					
Medical physicist					

Question 5 | DURING TRAINING

During my RANZCR Radiation Oncology Training, I have observed the following number of cases of brachytherapy for the following disease sites:

	0	1–5	6–10	11–15	16–20	>20
Definitive prostate cancer (LDR brachytherapy)						
Definitive prostate cancer (HDR brachytherapy)						
Definitive cervical cancer (intracavitary)						
Definitive cervical cancer (hybrid or interstitial)						
Adjuvant endometrial cancer (vaginal vault)						
Adjuvant breast cancer (interstitial)						
Skin cancer (applicator)						
Soft tissue cancer (interstitial)						

Question 6 | DURING TRAINING

During my RANZCR Radiation Oncology Training, I have participated in brachytherapy applicator insertion, and treatment plan review for the following number of cases of brachytherapy for the following disease sites:

	0	1–5	6–10	11–15	16–20	>20
Definitive prostate cancer (LDR brachytherapy)						
Definitive prostate cancer (HDR brachytherapy)						
Definitive cervical cancer (intracavitary)						
Definitive cervical cancer (hybrid or interstitial)						
Adjuvant endometrial cancer (vaginal vault)						
Adjuvant breast cancer (interstitial)						
Skin cancer (applicator)						
Soft tissue cancer (interstitial)						

Question 7 | DURING TRAINING

I believe the following brachytherapy training minimum requirement in the RANZCR Radiation Oncology Training Programme is considered adequate*.

*adequate such that I am/ will be comfortable performing brachytherapy applicator insertion and reviewing brachytherapy treatment plan at the end of my RANZCR Radiation Oncology Training.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
To complete 1 case report on prostate brachytherapy					
To complete 1 case report on gynaecology brachytherapy					

Question 8 | DURING TRAINING

My competency in performing brachytherapy applicator insertion and reviewing brachytherapy treatment plan has been adequately assessed in the RANZCR Radiation Oncology Training Programme.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

Question 9 | DURING TRAINING

I believe that there should be a minimum number of brachytherapy cases observed/ performed by trainees during the RANZCR Radiation Oncology Training programme.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
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Question 10 | DURING TRAINING

I believe that RANZCR Radiation Oncology Trainees should be involved in the following minimum number of brachytherapy cases (including observe, or participate in brachytherapy applicator insertion, and review brachytherapy treatment plan) for the following disease sites during RANZCR Radiation Oncology Training Programme:

	0	1–5	6–10	11–15	16–20	>20
Definitive prostate cancer (LDR brachytherapy)						
Definitive prostate cancer (HDR brachytherapy)						
Definitive cervical cancer (intracavitary)						
Definitive cervical cancer (hybrid or interstitial)						
Adjuvant endometrial cancer (vaginal vault)						
Adjuvant breast cancer (interstitial)						
Skin cancer (applicator)						
Soft tissue cancer (interstitial)						

Question 11 | POST-TRAINING (only for fellows)

Upon completion of my RANZCR Radiation Oncology Training Programme, I believe that I am/ I will be comfortable performing brachytherapy applicator insertion and reviewing brachytherapy treatment plan for the following disease sites, independently without direct supervision:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Definitive prostate cancer (LDR brachytherapy)					
Definitive prostate cancer (HDR brachytherapy)					
Definitive cervical cancer (intracavitary)					
Definitive cervical cancer (hybrid or interstitial)					
Adjuvant endometrial cancer (vaginal vault)					
Adjuvant breast cancer (interstitial)					
Skin cancer (applicator)					
Soft tissue cancer (interstitial)					

Question 12 | POST-TRAINING

Do you foresee yourself performing brachytherapy as part of your future clinical practice?

Yes

No

Question 12b (if 'Yes' to question 12)

How likely that you will pursue the following options to improve your brachytherapy competency following completion of your RANZCR radiation oncology training?

	Highly likely	Likely	Neutral	Unlikely	Highly unlikely
Local brachytherapy fellowship (within Australia/ NZ)					
International brachytherapy fellowship					
1–2-week brachytherapy observership					
ABG Clinical Brachytherapy workshop					
Other brachytherapy courses/ training					
On the job training with another radiation oncologists					
Other (please provide comments below)					

Question 13 | BARRIERS AFFECTING BRACHYTHERAPY TRAINING

I believe that the following are the main barriers affecting brachytherapy training in the RANZCR Radiation Oncology Training Programme:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Lack of number of cases in my training network					
Lack of formal teaching on brachytherapy					
Decreasing role of brachytherapy					
Personal lack of interest in brachytherapy					
Low level of brachytherapy competency requirement to obtain FRANZCR qualification					
Other (please provide comments below)					

Question 14 | OPINION REGARDING BRACHYTHERAPY UTILISATION

What do you think is the likely role of brachytherapy for the following disease site in the next 10 years?

	Increasing role	No change/about the same	Decreasing role
Definitive prostate cancer			
Definitive cervical cancer			
Adjuvant endometrial cancer			
Adjuvant breast cancer			
Skin cancer			

Question 15 | OPINION REGARDING BRACHYTHERAPY UTILISATION

The decline utilisation of brachytherapy for multiple disease sites is concerning.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

Appendix B**Barriers affecting brachytherapy training (free text answer to Question 13)**

There is little brachytherapy with sites within the QLD network and depending on the training sites you are allocated, you may never be exposed at all. To complete the case reports I have had to attend another hospital for a single prostate LDR case and cervical case

Not performed at my treatment site

not enough resources to perform brachy therapy at training site, that is, theatre availability, trainee rosters, etc

Brachytherapy for skin, breast, soft tissue sarcomas not practiced at all centres. Decreasing frequency of LDR prostate brachytherapy

No expectation nor requirement for consultants to involve registrars in cases. This should be a consult and college led part of training, not an obligation of trainees to 'find' opportunities

interdepartmental variation. Cases concentrated in quaternary centres

Have not yet done many rotations involving brachy and have only been in brachy centre for short period of time so not yet had time to get exposure.

Likely this will change and improve over next few years However, have little personal interest in all honesty given the invasive nature

Applicability to general practice and accessibility to specialised sites given covid restrictions

Brachytherapy previously highly centralised – fewer training opportunities and practice opportunities post training. Limited to certain specialties. Procedures also require ongoing training/practice

Within our college I feel our colleagues do not support the role of brachytherapy in treatment and also it is not well rebated compared to external beam radiotherapy, so there is less incentive for hospitals and ROs to go into this field

No direct evidence of superiority of brachytherapy in prostate cancer

Training is generally as attendance, rather than participation. It is easy to list off what is involved in prostate/cervix brachytherapy, but much harder to actually perform a safe brachytherapy implant. Without this experience, you cannot practice independently

Small number of sites which perform brachytherapy Lack of opportunity even at these sites (different rotations)

Service not provided at all training sites

Difficulty in being able to access rotations where certain types of brachytherapy are performed, for example: I will not have a gynae rotation until (hopefully) sometime in 5th year, and have not had any opportunity to be involved in gynae brachy. Have not done a rotation where other non-prostate brachy is used. I do not believe that classroom teaching is an adequate substitute for hands-on experience of doing brachytherapy have had some fantastic hands-on teaching for prostate brachy at my Centre, and have been able to take the lead for an LDR prostate patient, from initial consult, to volume study, to implant and follow-up. This experience was invaluable! Observerships may be worthwhile for trainees who will not get much exposure in their programme Even based at a centre that performs brachy, i have not been able to do it. The term is split between other ROs meaning you cannot get to brachy, and the term is always given away to rotating registrars

Lack of accessibility to brachy techniques at certain training sites

Lack of protected time for trainees to assist/ observe brachytherapy procedures
