The change to radiotherapy utilisation in a rural area after the establishment of a local service

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Abstract

Introduction: To investigate if the establishment of a rural radiotherapy service in the geographically sparse area of Western NSW Local Health District (WNSWLHD) has changed the demographic profile, cancer type, treatment intent and number of patients treated.

Methods: Data were collected on every WNSWLHD patient 17 years of age and above who received radiotherapy in either 2010 or 2012 in NSW or ACT. The age, gender, treatment intent, cancer type and residential town were recorded.

Results: The number of patients who accessed radiation increased from 573 to 667 between 2010 and 2012 ($x^2(1)=6.0$, p=0.014). The corresponding radiotherapy utilisation (RTU) rates were 29.3% in 2010 and 33.4% in 2012, an improvement of 4.1%. Patients travelled 128.5km less for treatment in 2012 than 2010 (338.7km vs 210.2km, CI 111km-145.5km, p>0.0001) and lived an average of 20km closer to the new the service (143.3km vs 123.6km, CI 7km-32km, p=0.002). All regions had an improvement in RTU rates apart from the remote region which decreased by 9% (31% to 20% in 2012). The number of palliative treatments increased significantly only within the Orange region, which is where the new service is situated (95% CI 1.2-3.0, p=0.004). Male treatments also significantly increased as there were 81 new treatments (292 vs 373, $x^2(1)=9.6$, p=0.002) as did patients with a respiratory cancer (66 vs 97, $x^2(1)=8.7$, p=0.003).

Conclusions: A new radiotherapy service in a sparsely populated health district significantly changed the pattern of radiotherapy use by those who lived in the Orange region and for those living in the Remote region, treatment rates worsened.

Introduction

It is well established that rural people have less radiation therapy than urban people and that increasing rural services improved rural radiotherapy rates [(1-4).]

These findings led to multimillion-dollar state and federal funding to expand rural oncology services [(5)]. In May 2011, WNSWLHD opened its first radiotherapy service in Orange. Prior to this, patients travelled outside the health service, primarily to Sydney, to receive treatment.

As radiation therapy is usually delivered daily for four to six weeks, the distance a patient travels for treatment is an important factor in the uptake of radiation because of the considerable financial, logistical, social and emotional costs associated with travel [(6-8)].

Although there have been studies around the impact of rural radiation services in Australia, this study is unique in that it evaluates the impact within a geographically sparse area. For example, some studies have defined rural as 300-500 people/km^2 [(9)]; comparatively WNSWLHD has a population density of 1 person/km^2 [(10)]. Therefore, these findings build upon current radiotherapy service planning knowledge as well as the impact of rural health services in geographically sparse areas of Australia.

Specifically, our study examined how radiotherapy treatment patterns have changed, to what extent, and for which population groups. It also determined whether or not the changes have been widespread or limited to the region surrounding the new service, located in the town of Orange.

In this study we define rural as a residential town with an ARIA (Accessibility Remoteness Index of Australia) score greater than 0.2, 100km from a capital city and with a local government area population of less than 50,000 people. All participants in this study meet our definition of rural.

Methods

This is a repeat cross sectional study, data was collected from patients who had radiotherapy in 2010 and compared with the patients treated in 2012.

The selection criteria were:

- patients 17 years of age and over
- a residential address within WNSWLHD
- received radiotherapy in the calendar years of 2010 and 2012
- treated with a megavoltage course in NSW or ACT
- diagnosed with a NSW Health notifiable cancer.

Every radiotherapy centre in NSW and ACT was a site for data collection. The reason for this is that WNSWLHD patients received treatment at all of the 22 radiotherapy centres in NSW and ACT (21 are within NSW and 1 centre is in the ACT). It captured 98% of the study population, as less than 2% received radiotherapy interstate and overseas [(11-12)].

Patients who had radiotherapy in 2011 were excluded because the WNSWLHD service took until the end of 2011 to reach full capacity [(13)]. Orthovoltage, brachytherapy and complex treatments were also excluded because these are not available at all radiotherapy centres.

Data extraction

Data managers from each centre extracted the required information, de-identified the patient data then transferred it to the coordinating principal investigator. Received information contained participants'; residential town and postcode; cancer diagnosis or ICD[1] code; age; treatment intent; place of treatment; gender; and year treated with radiotherapy.

Data coding

Records of patients who did not meet the inclusion criteria were not entered into the project database. Of the 1745 records received, 1240 (71%) were entered.

Cancer type was missing for 50 participants (4%), treatment intent was unknown for 66 participants (5%) and gender was not recorded for one participant. The missing data did not change the results when actual and estimated numbers were analysed.

Data analysis

Radiotherapy utilisation rate is defined as:

$$\frac{\text{The number of new radiotherapy courses}}{\text{The number of new cancer cases}}$$

As no patient identifiable details were collected, it was not known if the same patient was treated more than once. To find the number of new radiotherapy courses, a re-treatment rate of 21% was subtracted from the total number of treatments. This re-treatment rate was selected because it was the NSW RMIS[2] rate in 2010 and 2012 [(11-12)].

The number of new cancer cases was calculated by using 2008 WNSWLHD adult cancer incidence data and adjusting it to the 2010 and 2012 populations. i.e. the number of known new cancer cases in 2008 was divided by the population in 2008. This rate was then multiplied by the respective populations of 2010 and 2012. Standardised rates were based on 2008 cancer incidence, as it was the most recent NSW Cancer Institute data available.

[1] ICD= International Classification of Diseases
[2] RMIS= Radiotherapy Management Information System

Five year cancer prevalence was mainly used as the denominator for Chi square analysis. Prevalence was found using the same method to find cancer incidence. Where prevalence could not be used, such as for treatment intent, the proportion of one variable to another was compared i.e. palliative to curative treatment.

Independent samples T-tests were used for continuous variables, Chi- square for categorical variables, and univariate logistic regression to compare significance between regions. A p value of less than 0.05 was considered significant.

SPSS version 22 was the statistical package used to analyse results and Google maps was used to measure the distance in kilometres participants travelled.

Results

In total, there were 94 new radiotherapy treatments between 2010 and 2012 (573 vs 667), which represents a 14% increase over the study period. The increase was statistically significant ($x^2(1)=6.0$, p=0.014). The odds ratio of radiotherapy in 2012 compared with 2010 was 1.2 with a 95% CI (1.03-1.31).

The radiotherapy utilisation rate was found to be 29.3% in 2010 and 33.4% in 2012, an increase of 4.1%.

Geographical location

Table 1 shows that the average distance (km) from each participant's residential town to the radiotherapy centre at which they were treated dropped significantly in 2012. It also shows that with the presence of a local service, the average distance a WNSWLHD patient travels for treatment remains high (210.2km).

Table 1 Geographical distance

	Year	Mean(km)	Mean difference (95% CI)	P- value †
Distance travelled to the treatment centre	2010	338.7	128.5km (111km- 146km)	>0.0001
	2012	210.2		
Distance from patient's residential town to Orange	2010	143.3	20km (7km-32km)	0.002
	2012	123.6		

† Statistical test= Independent Samples T-Test

The distance from each participant's residential town to Orange was also measured to ascertain whether or not the dispersion of people having radiotherapy had changed. As shown in Table 1, patients receiving treatment lived an average of 20km closer to Orange in 2012 than 2010. This shows that people living closer to Orange are accessing more radiotherapy than before the service opened.

Geographical regions within WNSWLHD were analysed as they represent areas of commonality such as remoteness, specialist availability and treatment services. The regions are shown in Figure 1. They were drawn from the WNSWLHD Health Needs Assessment, which defined areas by combining Local Government Areas with similar ARIA and SEIFA[3] scores.

Table 2 shows that radiotherapy treatments within the Orange region improved significantly over the study period (p value= 0.001), with minimal increase in the Bathurst, Dubbo and North West regions. The number of radiotherapy treatments in the remote region decreased by 36%, which is not statistically significant when prevalence is used as the denominator (33 vs 21, p value=0.08).

[3] Socio- Economic Indexes for Areas

Figure 1 Map of regions within WNSWLHD

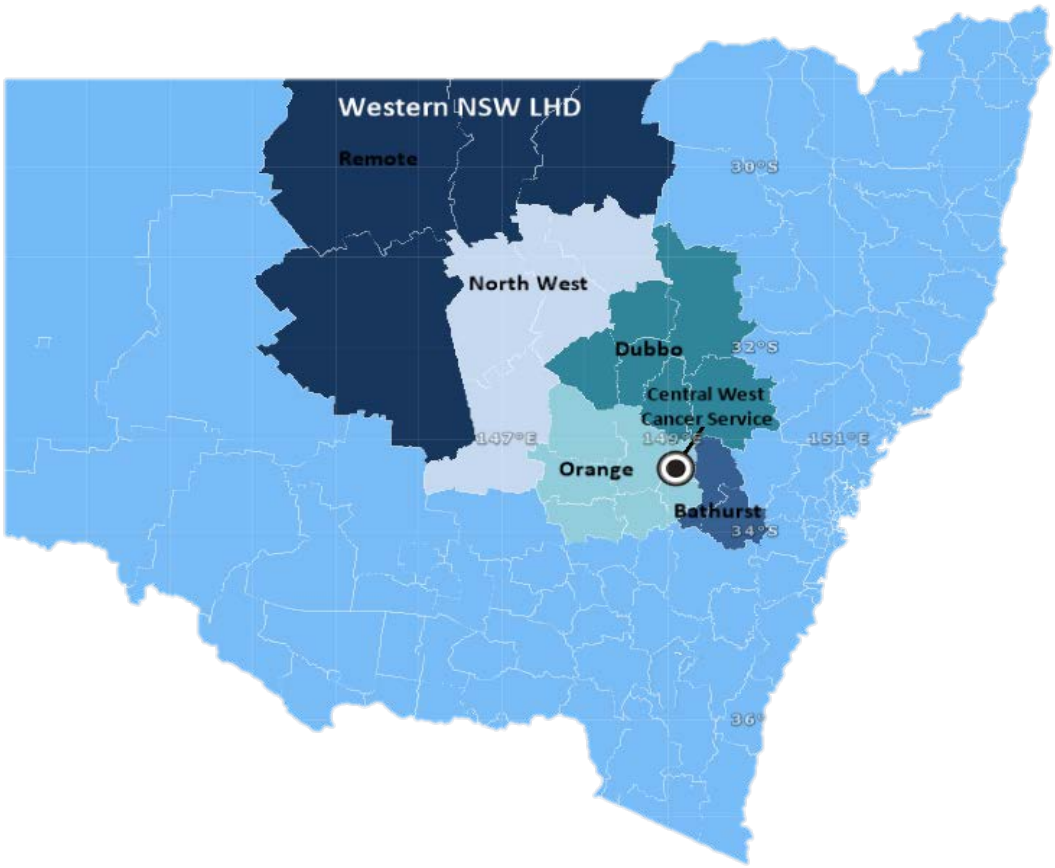


Table 2 Number of radiation treatments by residential region

Region	2010 n=573 n (%)	2012 n=667 n (%)	OR (95% CI)	p value †
Bathurst	86 (15%)	102(15%)	1.2(0.9-1.6)	0.28
Orange	219(38%)	296(44%)	1.4(1.1-1.7)	0.001
Dubbo	195(34%)	206(31%)	1.0(0.8-1.3)	0.69
North West	40(7%)	42(6%)	1.0(0.7-1.6)	0.90
Remote	33(6%)	21(3%)	0.6(0.3-1.1)	0.08

† Statistical test= Chi- square

Table 3 Radiotherapy utilisation rates by residential region

Region	2010 RTU	2012 RTU	Change %
Bathurst	32%	37%	+ 5%
Orange	30%	40%	+ 10%
Dubbo	27%	28%	+ 1%
North West	31%	32%	+ 1%
Remote	31%	20%	-9%

However remote region results need to be interpreted with caution. Because there were small numbers in the group, there is considerable variability from year to year in the number of people treated with radiotherapy, and the number diagnosed with cancer.

The RTU rate in 2012 in the remote region was also the lowest of all the regions (Table 4) and the only region to show lower treatment rates after the opening of the WNSWLHD radiotherapy service.

Table 4 Number of palliative courses by residential region

Region	2010 n=175 n(%)	2012 n=254 n(%)	OR (95% CI)	p value †
Bathurst	25(14%)	33(13%)	1.3(0.7-2.3)	0.46
Orange	62(35%)	125(49%)	1.9(1.2-3.0)	0.004
North West	9(3%)	11(7%)	1.2(0.5-3.0)	0.74
Remote	11(6%)	8(3%)	0.7(0.3-1.8)	0.47
Dubbo	68(39%)	71(28%)		reference

† Statistical test= Univarate logistic regression (Wald: 10.6(4) p=0.03)

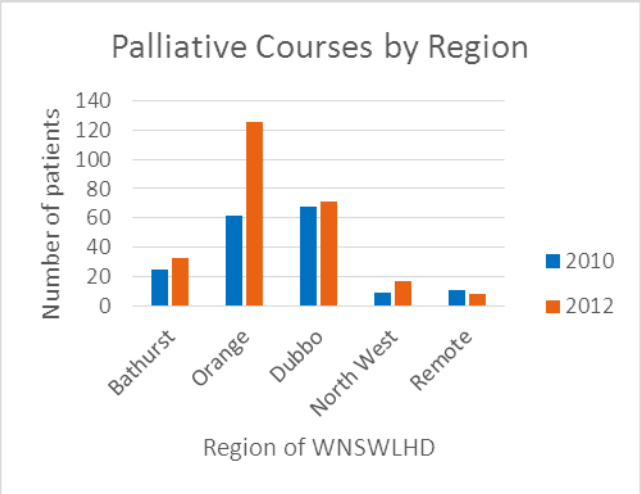
In the Orange region, the RTU rate increased by 10% over the period, whereas the Dubbo region, which is comparable in terms of population size and medical facilities, but primarily serviced by an outreach radiotherapy clinic, increased by 1%.

Treatment intent

The proportion of palliative to curative treatments between 2010 and 2012 was not statistically different ($x^2(1)=2.06$, p=0.15). Estimated values were analysed to check if the missing data (5% of cancer type was missing) altered the results. The p value was very similar to the p value obtained from the original data (p=0.112 vs p=0.15), showing that the missing data did not affect results.

By breaking palliative treatments into regional areas, it was found that 78% (62/79) of new palliative treatments were for patients from within the Orange area (Figure 2). The increase in palliative treatments over the two year period was statistically significant, p=0.004 (Table 4). There were no statistically significant increases in treatment rates in the other regions.

Figure 2 Palliative courses by residential region



Gender

There were 67 more males treated than females between 2010 and 2012 (Table 5). The proportion of male to female treatments was not statistically different (p= 0.086). However the proportion of male courses to the number of males living with cancer (five year prevalence) showed that the increase in treatment rates in 2012 was statistically significant (p=0.002) compared to those treated in 2010. For females, the number of treatment courses to the number living with cancer did not change between 2010 and 2012 (p=0.75).

Table 5 Gender changes to radiation treatments using prevalence as the denominator

Gender	2010 n=573 n (%)	2012 n=667 n (%)	OR (95% CI)	p value †
Male	292(51%)	373(56%)	1.3 (1.1-1.5)	0.002
Female	280(49%)	294(44%)	1.0 (0.9-1.2)	0.75

† Statistical test= Chi- Square

Age

Table 6 shows that there was no statistically significant association between patient age and the presence of a more accessible radiation service in this study.

Table 6 Changes to age between 2010 and 2012

Age (years)	2010 n=573 n (%)	2012 n=667 n (%)	OR (95% CI)	p value
Mean	64.9 yrs.	66.1 yrs.	mean diff: 1.2 yrs. (-0.2-2.5)	0.09*
17-49	66(12%)	58(9%)	0.9(0.6-1.3)	0.46**
50-64	205(36%)	224(34%)	1.1(0.9-1.3)	0.48**
65-79	237(41%)	294(44%)	1.2(1.0-1.4)	0.08**
80+	65(11%)	91(14%)	1.4(1.0-1.9)	0.07**

* Statistical test= Independent Samples T-Test, ** Statistical test= Chi- Square

Cancer type

Overall there was minimal change in the type of cancers treated over the study period. The five most common cancer types treated were; breast, prostate, lung, skin and rectum.

Respiratory, upper GI and lymphohaematopoietic clinical groups had the most significant increases with p values of 0.003, 0.008 and 0.01 respectively. Upper GI and lymphohaematopoietic were small groups and therefore had wide confidence intervals which makes the result less reliable and potentially misleading.

The increase in respiratory cancers, however, is significant because patient numbers were larger. The difference in the number of patients treated between 2010 and 2012 was 19% (66 vs 97). Of the 31 new patients treated, 27 (87%) were palliative courses.

Table 7 Cancer clinical groupings

Cancer Clinical Group	2010 n=573 n (%)	2012 n=667 n (%)	OR (95% CI)	p value †
Breast	136(24%)	146(22%)	1.1(0.8-1.4)	0.64
Urogenital	109(19%)	139(21%)	1.3(1.0-1.7)	0.07
> *(Prostate)‡*	*92(16%)*	*123(18%)*		
Respiratory	66(12%)	97(15%)	1.8(1.2-2.7)	0.003
Skin	63(11%)	62(9%)	1.0(0.7-1.4)	0.83
Colorectal	45(8%)	43(6%)	0.9(0.6-1.4)	0.75
Head and Neck	28(5%)	37(6%)	1.4(0.8-2.4)	0.24
Gynaecological	23(4%)	29(4%)	1.3(0.7-2.3)	0.43
Upper GI	15(3%)	32(5%)	2.4(1.2-4.7)	0.008
Neurological	14(2%)	16(2%)	1.3(0.5-3.5)	0.61
Lymphohaematopoietic	13(2%)	29(4%)	2.3(1.2-4.5)	0.01
Ill-defined and Unknown	12(2%)	17(3%)	1.6(0.7-3.7)	0.3
Other	9(2%)	10(1%)	1.1(0.4-2.8)	0.84

† Statistical test= Chi- Square, ‡ the significance of prostate treatments was not tested as prevalence was obtained for only cancer clinical groups and not cancer types

Discussion

The overall RTU increase of 4.1% from 2010 to 2012 shows that the new service has had a beneficial impact in its first full year of operation. Despite the analytical limitations in calculating the RTU rate, the results in this study are comparable to RTU rates seen other studies.

For example, the most relevant, accurate and recent estimation of RTU currently in the literature is a 2004-2006 study that found the utilisation rate for NSW was 26% [(14)]. Our study found the RTU for 2010 and 2012 was, respectively, 29% and 33%, which verifies the reliability of these results.

Our study also found that the average distance travelled for patients to receive treatment decreased from 339km to 210km (difference 129km, p=0.0001). This is a major improvement, however 210km is still a distance the majority of patients would not travel daily; around half the patients in the study still required accommodation, time away from home and work in order to receive radiotherapy.

In 2012, the one linear accelerator located in Orange was already operating at full capacity. In 2012, however, 39% of WNSWLHD patients were treated in Sydney, showing that the local service needed to increase capacity. A second linear accelerator was opened in 2013. Once the second linear accelerator reaches full capacity, a follow up study to re-examine treatment rates across regions would be useful.

The study also found a significant improvement in radiotherapy rates in the region surrounding the new service (Orange). It was the only region in the study to show significantly higher radiotherapy treatment rates (p=0.001) and 78% of new palliative treatments were from this region. These findings illustrate that distance to a radiotherapy service markedly influences treatment uptake.

For those living in the remote region, treatment rates decreased over the study period. As there were smaller numbers in this group, the result is exposed to variability. Despite this, it is concerning that there was no improvement over the two year period even though every other region showed an increase in treatment rates.

For those in the furthest and most isolated WNSWLHD regions (North West and Remote), it is not feasible, practical, or sustainable to build a closer radiotherapy service [(15)], and thus distance will remain a significant deterrent and barrier to accessing radiotherapy services. These regions tend also to have a higher proportion of people from lower socioeconomic backgrounds. Even with IPTAAS (Isolated Patient Travel and Accommodation Scheme) subsides, travel costs can be substantial and a real barrier to accessing treatment for some people [(10)]. It is recommended that alternative strategies

be considered to improve access to care for this group of people. One practical solution is to provide higher subsides for travel and accommodation costs. Similar initiatives implemented in other countries have effectively eliminated variations in access between rural and remote regions [16].

The difference in radiotherapy utilisation rates between the Dubbo and Orange region is an important finding in this study because it shows the difference in treatment uptake between two similar areas that have different health service models. Dubbo, which is similar to Orange in terms of population size, specialists and services, has continued to operate an outreach clinic from Royal Prince Alfred Hospital (RPAH) due to the limited capacity of Central West Cancer Service.

Between 2010 and 2012 the radiotherapy utilisation rate in Orange increased by 10% (from 30% to 40%), whereas in Dubbo the rate only increased by 1% (from 27% to 28%). This suggests that a local radiotherapy service is far more effective in increasing the radiotherapy utilisation rate than an outreach clinic.

The surge in the number of males treated is most likely attributed to improved access. The types of cancers males received radiotherapy for during the study period was evenly dispersed through all cancer clinical groupings. Therefore it is unlikely the increase in the number of males treated is due to external factors such as the number of PSA[4] tests prescribed that year, and thus the number of prostate cancers diagnosed.

Patients with a respiratory cancer also had a significant increase in radiotherapy treatments over the study period. Results show that 87% of the new respiratory treatment courses were palliative. Exactly why this cancer clinical group increased more than any other is not known. The vast majority of new palliative courses were from within the region surrounding the new service, so the improved access to care may be part of the reason for the higher treatment rate.

Limitations

One limitation of this study was that patient identifiable details were not collected. This meant that it was not possible to determine whether the same patient was treated at a different radiotherapy centre, or treated more than once. This limitation was managed by calculating in a re-treatment rate of 21% and using prevalent cases instead of prevalent people in the denominator estimations.

Using denominator estimations was also an analytical limitation; it would have been preferable to know the actual number of people living with cancer in the region. This was not possible, however, as NSW Cancer Institute's most recent data was from 2008.

Conclusion

The opening of a rural radiotherapy unit in WNSWLHD has improved the overall radiotherapy utilisation rates. The region closest to the new service was the only area that had a significantly higher number of patients treated in 2012. This was particularly apparent in the number of new palliative patients who resided in the Orange region. Males and patients with a respiratory cancer also had significantly more radiotherapy in 2012 than 2010.

As radiotherapy rates in the remote region decreased over the study period, this study shows that a service 300km away is unlikely to have a benefit on treatment rates. As radiation services for remote residents will nearly always be located a long distance away, more needs to be done to reduce the travel and accommodation costs for patients if radiotherapy utilisation is to be improved for this group.

Recommendations

1. It is recommended that WNSWLHD, NSW Health and the Commonwealth Department of Health continue to support the second linear accelerator in Orange, in terms of resources and staffing. This is to enable the two linear accelerators to reach full capacity and be able to treat all WNSWLHD patients requiring non-complex megavoltage radiotherapy.

[4] PSA= Prostate- Specific Antigen

2. For those living in the remote regions of NSW (or greater than 300km from a radiation centre), other strategies to increase the uptake of radiotherapy need to be strengthened. Evidence from other studies shows one practical solution would be to increase IPTAAS and subsidise 100% of travel and accommodation costs.

3. Evaluation of radiotherapy utilisation in WNSWLHD should be reviewed once the second linear accelerator reaches full capacity.

Acknowledgments

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References

1. Roder D, Zorbas H, Kollias J, Pyke C, Walters D, Campbell I, et al. Risk factors for poorer breast cancer outcomes in residents of remote areas of Australia. Asian Pacific Journal of Cancer Prevention. 2013; 14(1):547-52.

2. Khor R, Bressel M, Hun Tai K, Ball D, Duchesne G, Rose W, et al. Patterns of retreatment with radiotherapy in a large academic centre. Journal of Medical Imaging and Radiation Oncology. 2013; 57(5): 610-6.

3. Lavergne R, Johnston G, Gao J, Dummer T, Rheaume D. Variation in the use of palliative radiotherapy at end of life: Examining demographic, clinical, health service, and geographic factors in a population based study. Palliative Medicine. 2011; 25(2): 101-10.

4. Schroen AT, Brenin DR, Kelly MD, Knaus WA, Slingluff CL. Impact of patient distance to radiation therapy on mastectomy use in early- stage breast cancer patients. Journal of Clinical Oncology. 2005; 23(28): 7074-80.

5. NSW Health. Radiotherapy Services in NSW: Stategic Plan to 2016. Statewide Service Plan. No 7. North Sydney : NSW Department of Health, 2010.

6. NSW Health. Factors that impact on referral rates for radiotherapy. Planning Document. North Sydney : Statewide and Rural Health Services and Capital Planning Branch, 2011.

7. Martin-McDonald K, Rogers-Clark C, Hegney D, McCarthy A, Pearce S. Experiences of regional and rural people with cancer being treated with radiotherapy in a metropolitan centre. International Journal of Nursing Practice. 2003; 9: 176-82.

8. Mercuri A, Susannah K. Needs of cancer patients treated in rural and urban cancer departments. The Radiographer. 2005; 52(3): 21-5.

9. Koning CC, Aarts MJ, Struikmans H, Poortmans PM, Lybeert ML, Jobsen JJ, et al. Mapping use of radiotherapy for patients with non-small cell lung cancer in the Netherlands between 1997 and 2008. Journal of Clinical Oncology. 2012; 24(2): 46-53.

10. Western NSW Local Health Disrict & Western NSW Medicare Local. Western NSW Health Needs Assessment 2013. Dubbo : WNSWLHD & ML, 2013.

11. NSW Health. 2010 Radiotherapy Management Information System Report. Sydney : NSW Department of Health, 2011.

12. NSW Health. 2012 Radiotherapy Management Information System Report. Sydney : NSW Department of Health, 2013.

13. Western NSW Local Health District. Western NSW Local Health District Cancer Plan 2013-2018. Dubbo : Western NSW Local Health District, 2012.

14. Gabriel G, Barton M.B., Delaney G.P. Radiotherapy Utilisation in NSW and ACT 2004-2006: A data linkage and GIS experience. Collaboration for Cancer Outcome, Research and Evaluation (CCORE), Ingham Institute, Liverpool Hospital, Sydney Australia. RANZCR 2013.

15. Commonwealth Department of Health and Ageing and Victorian Department of Human Services. Establishing radiation oncology in regional areas: Experiences of the national radiotherapy single machine unit trial and other regional radiation oncology models. Canberra : Australian Government Department of Health, 2010.

16. Nieder C, Norum J, Spanne O, Bilberg I, Vagstad G, Dalhaug A. Does distance to treatment centre influence the rate of palliative radiotherapy in adult cancer patients? Anticancer Research. 2009;29(7):2641-4.

Presenter

Sally Butler works as a radiation nurse at Central West Cancer Service in Orange, NSW. The idea for the project was formed after a number of patients told her they would not have had radiotherapy if the new service at Orange did not exist. Sally is currently completing a Master of Biostatistics and plans to continue her research in rural oncology services.