Does increased geographical distance to a radiation therapy facility act as a barrier to seeking treatment?

Divya Kiran Sharma
Sixth Year Medicine (Undergraduate)
James Cook University

Divya Kiran Sharma is in her final year of her medical degree at James Cook University. She has graduated from the University of Toronto with a Bachelor of Science degree in Medical Radiation Sciences and has worked in Halifax, Nova Scotia, Canada, and in Townsville, Australia as a radiation therapist. Her pastimes include distance running, hiking, and travelling.

Introduction: Radiation Therapy (RT) is a common treatment modality for cancer management. Due to specific licensing and expertise requirements, RT tends to be centralised in larger urban centres resulting in restricted geographical access for many. Several studies conducted have examined the relationship between distance to treatment and utilisation of RT, however there remains a gap in literature with regards to Australian geography, particularly in rural areas where land is vast and treatment facilities are few. This review aimed to address the question: "Does increased geographical distance to a RT facility act as a barrier to seeking treatment?" **Methods**: The SCOPUS and Cumulative Index of Nursing and Allied Health Literature (CINAHL) databases were searched for articles pertaining to geography, access, and radiotherapy for all cancer diagnoses. Specific inclusion criteria were applied and the quality of the studies were assessed. **Results**: Twelve studies were eligible for inclusion in the review. Of these, nine studies identified a negative relationship between distance to RT facility and RT treatment, one study determined a positive relationship between geographical distance and RT treatment, and two studies noted public transportation as a barrier to RT treatment. **Conclusion**: This review suggests that there may be an inverse association between distance to treatment and utilisation of RT. However, studies were limited by retrospective design and prospective studies are required before firm conclusions can be drawn. In order to apply these findings to rural Australian settings, it would be ideal to examine data in local areas to determine if these populations are serviced adequately and where there are areas of underutilisation of RT.

Introduction

Radiation Therapy (RT) is a common treatment modality for a multitude of cancer diagnoses. RT may be used for radical or palliative intent; to provide disease control or improve quality of life. [1] The radiation dose is fractionated, delivered daily over weeks, and can in some cases take as many as nine weeks to achieve prescribed radiation doses. [2-4] It is a highly technical treatment that uses imaging options such as: Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Positron Emission Tomography (PET) scanning to accurately delineate the tumour volume. Utilising the skills of radiation oncologists and radiation therapists, a precise dose of radiation is delivered to this targeted volume, destroying cancer cells whilst sparing normal tissue where possible.

Radiotherapy requires multidisciplinary input, for example from nursing, medical oncology, palliative care, dietetics and speech pathology. [5,6] For many patients it is the treatment of choice and yields excellent five year survival rates for localised solid tumours. [7] Due to the specific quality control measures, equipment and licensing requirements, substantial cost of treatment machines and the expertise required, the location of RT facilities tends to be centralised in larger urban centres, subsequently restricting access to those located in more regional and rural areas. [3,8,9]

Despite its therapeutic advantages, there are several factors that patients may consider prior to attending RT facilities, one of which is accessibility. For many patients the distance to a RT facility and the protracted course of treatment means that RT is not a feasible option. Challenges in accessing RT may lead to suboptimal treatment and subsequently poor outcomes for cancer patients. [1,3,7] Several studies have investigated the association between geographical distance to radiotherapy and radiotherapy utilisation, however they are limited by small sample sizes and differ in their conclusions. Accordingly, a systematic review was conducted to assess whether greater geographical distance to a RT facility was a barrier to RT treatment.

Methods

Search-strategy

A search strategy was devised according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement. [10] The SCOPUS (incorporating 100% of Medline titles) and Cumulative Index of Nursing and Allied Health Literature (CINAHL) databases were searched using the following search terms: *(geograph* distance OR access)* AND *(radiation therapy OR radiotherapy)*, from January 1, 2000 to June 26, 2013 applied to abstracts.

Inclusion criteria

Studies were included if factors associated with access to or inequalities in receiving RT or cancer treatment were noted on all diagnoses of cancer. Studies were included if they were in the English language, pertinent to humans and linked to publically available full text articles.

Exclusion criteria

Studies were excluded if the primary objective did not include geographical distance or access barriers to RT facility or cancer treatment; if the study focused on treatments rather than barriers to treatment; or if the data was published prior to 2000.

Data extraction and quality assessment

Studies were independently abstracted for quality assessment by the primary author with corroboration from co-authors. Quality assessment was based on the study design, sample size, control for confounders, and control of bias. [11,12] The studies were rated as high (H), moderate (M) or low (L) quality based on study design, execution, and reporting. High quality suggested a prospective study design with a large sample size, considerable control of confounders, and little bias, whereas low quality reflected a small sample size, limited control of confounders, and significant bias.

Results

The search of the SCOPUS database yielded 57 results, of which 22 met the eligibility criteria, with 11 that were relevant to geographical

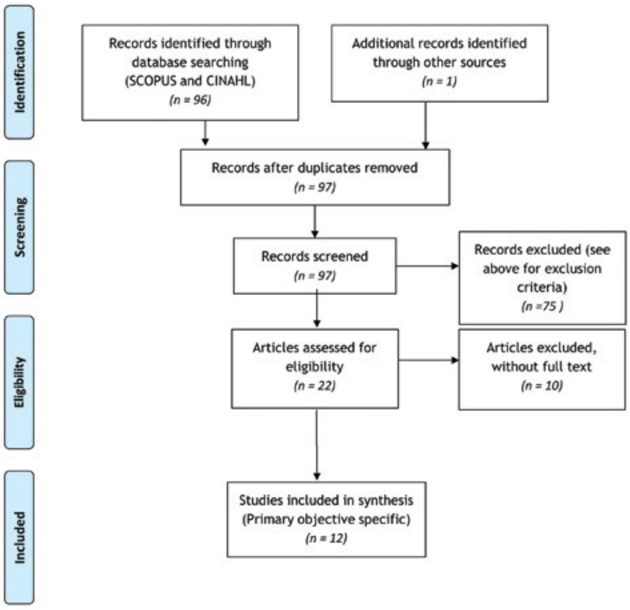

Figure 1. *PRISMA Flow Diagram*

distance and variations in access to RT and available in full text. Repeating the search in CINAHL provided 39 additional results of which no articles were deemed relevant to the primary aims of this systematic review. One additional study was identified from grey literature searching and was included in the review, resulting in a total of 12 studies (Figure 1).

The quality of the included studies is shown in Table 1. As most of the studies were retrospective in study design where data examined was retrieved from cancer registries, they tended to be of moderate quality assessment. Overall, two studies were deemed to be high quality and ten studies were considered to be of moderate quality. None of the included studies were considered to be of poor quality.

The geographical location of each study is summarised in Table 2. Of the 12 studies, eight were conducted in the United States, one study was conducted in Canada, one study was conducted in the United Kingdom and two studies were conducted in Australia with a mixture of urban and rural settings. Several studies utilised geographic information system (GIS) software to map and measure the distance from the patient's residence to the RT facility to give an indication of the accessibility of the RT clinics. Distances were calculated using straight line measurements rather than the actual route travelled by the patient via the software.

Of the 12 studies that met the inclusion criteria, nine identified a negative relationship whereby the greater the distance to the RT facility, the less likely the patient would be to undergo RT. [1,3,4,7-9,13-15] One prospective study with moderate control for confounders determined a positive relationship, whereby the greater the distance to the RT facility, the greater the likelihood of receiving RT. [16] There were two studies that did not address the distance to the RT clinic, but instead noted that lack of public transportation to RT facility was an access barrier, and that the presence of a radiation oncologist reduced mortality rates. [2,17] Although these two studies did not specifically address the primary objective, their results indicate that travel time to RT clinics is a major barrier to patients and that local resources such as radiation specialists can improve prognoses. Synthesis of the study data yielded a list of factors that were considered to influence access to RT (Box 1). The most influential factors contributing to radiotherapy access included: shorter distance to the RT facility, higher socio-economic status (SES), and increased education.

Discussion

The findings of this review suggest that geographical distance to RT facilities is a barrier to RT treatment. The majority of the studies included found that with increased distance to the RT facility, there was lower utilisation of RT as a treatment. One study conducted in Queensland, Australia reported conflicting findings, suggesting that with increasing distance to RT facilities there was higher utilisation of RT. This study focussed specifically on the prostate cancer population in Queensland, which is often an older population and therefore may have other factors that influence RT accessibility, such as retirement, income, and doctor preferences, whereas other studies often looked at cancer patient populations in younger cohorts. Older populations may not have to factor in time away from employment, and may have family they can reside with that live in regional centres. They may have previous exposure to hospitals and specialists, and therefore may have alternative factors that impact on preferences for location. [16] The findings of this study were potentially also limited by confounding bias as stated by the authors.

Box 1. *Factors identified that influence access to RT.*

- Resource availability of RT [1]
  - o Adequate staff in RT [9]
- Geographical distance to RT facility
  - o ↑ distance from patient residence to RT facility ↓utilisation of RT [1,3,9,13]
  - o ↑distance to RT facility ↑increased utilisation of RT [16]
- Physician preference and training [3,7,14]
- Accessibility of the RT facility (public transport) [14]
- Socioeconomic Status (SES)
  - o higher SES corresponds to increased RT utilisation [3,7,8,13-17]
- Level of patient education [2,7,14,17]
- Age
  - o Younger more likely to undergo RT [2,4,14]
  - o Older more likely to undergo RT [16]
- Hospital reputation [14]
- Referral patterns [8,14]
- Health insurance [2,4,8,13]
- Marital status
  - o Married more likely to undergo RT [4]
  - o Social support [13,15]
- Travel subsidy or reimbursement [7,9]
- Culture [7,14]
- Race
  - o Caucasian population are more likely to undergo RT [2,4,17]

It is important to note that there was considerable variability in the geographical setting of the included studies. One study was conducted in a metropolitan city in the USA and the results may not be applicable to Australian settings. Interestingly, at least one study from each nation and the majority of research included in this review found that increased distance to RT facilities can act as a barrier to utilisation of RT, suggesting that this is a global phenomenon.

It would be useful to qualitatively investigate why patients select RT as their treatment option to ascertain insight into the barriers patients subjectively experience. With lower population density and lack of available RT facilities in rural areas such as Northern Queensland, there are great distances that must be traversed in order to receive life-saving treatment. Public transportation alone cannot be considered a barrier in instances where it is not available to patients, as is the case in remote areas. Therefore it is important to investigate area-specific geographical barriers, as rurality may pose other obstacles to overcome. It would also be interesting to explore whether variations exist in the acceptance of RT during the wet season when driving conditions could be challenging. This area of cancer care deserves much attention, especially in areas with vast land and few facilities. Identifying barriers to receiving RT is crucial to addressing the needs of the population.

Limitations of the studies synthesised in this review include the fact that many studies investigated distance to treatment rather than actual road travel times, which can vary significantly in many areas in Australia due to factors such as traffic, road works, the wet season and mountainous regions. There remains controversy in the optimal methodology used to assess accessibility to treatment. The GIS methods that were cited in this review were variable in their measurement of distance, often utilising straight line methods or mile radius buffer zones, which are not representative of the course travelled by the patient and do not give a clear indication of travel time. It is likely that increasing the accuracy of GIS distance measurements, by using round distance or alternatives as opposed to straight line measurements would exaggerate rather than minimise these differences.

This systematic review has a number of limitations. Firstly, two databases were utilised in the literature search and only open-access full text manuscripts were included, therefore restricting the amount of literature reviewed. Secondly, the methodological quality of the majority of included studies was moderate. The studies examined were either of retrospective or prospective study design. Most studies identified that the decision to proceed with RT is multifactorial, and many adjusted for a limited number of confounders. An ideal study would follow each patient with a diagnosis of cancer prospectively through a questionnaire or interview to ascertain which factors act as barriers or enablers to the decision for treatment. It would then revisit the patient post treatment to assess for any changes or additional challenges met. This would be a time-intensive process which would involve long follow up of patients, and may potentially be intrusive to patients during an emotional and difficult period in their life. Finally, the scope of the literature search was expanded to include all geographical locations rather than confining the search to rural areas in Australia alone due to the paucity of literature available. The results are therefore limited in their transferability to Australian settings.

Creating new technologies to deliver better dose profiles to tumour volumes is an integral part of radiation therapy, but however precise these treatments can be, their use is of limited value to populations who are not able to access RT. [18,19] Uniquely, radiotherapy will always need to be delivered in larger centres unlike other areas of oncology where initiatives such as tele-oncology are overcoming geographical access barriers. Therefore, further work in determining the role of innovative strategies to minimise the time patients spend away from home in rural areas and the burden associated with receiving treatment would be useful. [20,21]

Conclusion

Multiple factors are considered in the decision making process to have radiotherapy versus alternative treatments and these remain individual and context specific. Access to the RT facility is one important factor considered in this review. [22] The preference for modalities is important to investigate as studies have indicated a discrepancy between evidence based optimal and actual utilisation rates of RT. [1,23,24] The multitude of factors and social context that influences the patients' choice for and satisfaction with treatment makes this a complex and significant area of research. [22,25] This review indicates that most likely rurality and increased distance from RT centres are important considerations, thus there is also the requirement for additional research into areas that may improve access for the rural cancer patient population, including travel subsidies, accommodation, and location of treatment facilities. However, there is a need for further studies, ideally prospective, and geography specific, before firm conclusions can be drawn.

Acknowledgements

The author would like to thank Associate Professor Sarah Larkins for her guidance and support. This research was conducted as part of a James Cook University School of Medicine Research Scholarship awarded in 2013.

Conflict of interest

None declared.

Correspondence

D K Sharma: divya.sharma@my.jcu.edu.au

Table 1. *Quality assessment of articles meeting inclusion criteria. Study Quality: High (H) Moderate (M) or Low (L).*

Study	Study Design	Sample size	Control for confounders	Methodological issues
Soo J, *et al.* (2010)	Retrospective cohort study investigating all invasive prostate cancer patients diagnosed from January 1st 1986 – December 1999 and all RT treatment from January 1986-April 2005. (M)	Not reported.	Incident data and treatment data are not coincident, however prostate cancer disease time may be long and this enables lengthy follow up. (M)	No sample size and no measure of effect bias. Did not examine other factors that may impact access, e.g. resource availability. (L)
Aneja S, *et al.* (2012)	Mapping of primary care physicians in non-rural counties. (H)	2472 non-rural counties. (H)	Used a 5 year time period to account for changes in the workforce. Considered socioeconomic and demographic factors. (H)	No identified bias or problems with methodological rigour. (H)
Schroen AT, *et al.* (2005)	Retrospective cross-sectional analysis of early-stage invasive female breast cancer patients comparing distance to RT facility vs mastectomy rates. (M)	20,094 women. (H)	Large sample size study that examined distance as a single factor to investigate its influence of patient decision. Compared similar stages of breast cancer patients. (H)	As comparisons were made based on distance as the exclusive factor and with patients of similar staging, no biases were identified. (H)
Voti L, *et al.*(2005)	Retrospective analysis using GIS software to measure the distance from patient address to the facility. (M)	18,903. (H)	Considers other factors that may influence treatment choice i.e. health insurance, marital status, etc. (H)	Euclidean distance measurement used. Other factors that may promote use of mastectomy i.e. pregnancy, previous RT of the breast etc) not accounted for with retrospective registry data (L)

Cetnar JP, *et al.* (2013)	Retrospective analysis using GIS software to measure the distance from patient address to the facility. (M)	Random selection of 1096 men from 3220 eligible. (H)	Selection of patients across race/ethnicity and state specific factors. Oversampling of minorities for comparison of race and ethnicity. (H)	Non-curative treatment was deemed as hormonal therapy, active surveillance or watchful waiting, but may be the first line choice for some. (M)
Athas WF, *et al.* (2000)	Retrospective analysis using GIS software to measure the distance from patient address to the facility. (M)	1122. (M)	Use of centroids for PO BOX when ZIP codes only were available. (M)	Assumed that each patient was treated at the nearest facility. ZIP code centroids may cause a spurious result. Did not include Native American women. (L)
Underhill C, *et al.* (2009)	Self-administered survey completed by regional hospitals administering chemotherapy (RHAC). (M)	157 RHAC (98% response rate). (H)	Survey rather than retrospective analysis. (M)	Variable interpretation of the survey by participants. De-identified participants may have led to duplicated responses. Quantity of services investigated, not quality. (L)
Baldwin LM, *et al.* (2012)	Retrospective analysis of SEER data from 2000 to 2004 of breast cancer and four "other cancers". (M)	122,526 cancer patients. (H)	Addressed primary variable (urban vs rural residence) and secondary variables (poverty, low employment, low education and availability of radiation oncologist). Controlled for patient socio-demographics, and regional practice variation. (H)	Unable to use patient address from database, therefore reliant on county level distance to RT facility rather than individual travel distance. (M)
Boscoe FP, *et al.* (2011)	Retrospective analysis using GIS software to measure the distance from patient address to the facility. (M)	104,730. (H)	Both centroid distance via census tract to RT facility and residential address used. Considered confounding variables i.e. age, primary tumour etc. (H)	Incomplete radiation data limited results. Potentially underestimated distance to surgery and inaccuracies in geocoding. (M)
Williams MV, *et al.* (2009)	Analysis of a retrospective audit of wait times for RT during one week: 24 September 2007 to 30 September 2007. (M)	2504 patients excluding skin cancer (H)	A one week snapshot in time project, with little control for confounders. (L)	Primary outcome defined as 1st course of RT, as opposed to completed treatment, cure or survival. (M)
Baade PD, *et al.* (2012)	Prospective trial of men diagnosed with prostate cancer between 2005 and 2007. Data obtained via telephone and self-administered questionnaires. (H)	956 men. (M)	Prospective study. Confounding factors considered ie. demographic and Quality of Life (QoL) indicators. (H)	Stage recorded based on the patient's description of local, locally advanced, or advanced disease – recall bias may skew results (95% concordance with registry). (M)
Peipins LA *et al.* (2013)	Cross-sectional GIS and network analysis to quantify spatial accessibility to RT. (M)	282. (M)	Considered race, household income and access to a vehicle. Multimodal transport including bus, rail and wait times/walking to transport compared with personal vehicle transfer. (H)	Did not account for daily variations, traffic, parking time etc. Assumed those without a private vehicle were taking public transport and that all subjects would go to the nearest facility. (L)

Table 2. *Literature summary.*

Article	Setting	Participants	Geographical details	Results
Soo, J. *et al.*	British Columbia, Canada	Palliative prostate radiotherapy patients from January 1986 – December 2005.	Mix of urban, suburban, rural and remote.	Increased utilisation rate of RT for rural and remote patients. Increased distance to RT clinic led to less usage of RT. Opening additional RT facility increased RT utilisation. N.B. No measure of effect size given.
Aneja S, *et al.*	2472 non-rural counties in United States	Radiation oncologist, primary care physician and urologist density per 100,000 people mapped to the included counties.	Only non-rural counties considered.	Presence of a Radiation Oncologist (RO) had a significant reduction on the mortality rate of prostate cancer patients until "plateau effect". ≤1 RO: 3.65% mortality reduction, 95% CI 5.54-1.76% (p = 0.031). 2 – 4 ROs: 1.48% mortality reduction, 95% CI 2.73 – 0.23% (p = 0.045).

Schroen AT, *et al.*	Virginia, United States	All female Virginia residents diagnosed with local or regional breast cancer (SEER) between January 1st 1996 and December 31st 2000.	Variations in access to health care and SES. Mix of rural, suburban and highly urbanised areas.	Greater distance to RT decreased the likelihood of receiving breast conserving treatment (BCT), independent of tumour size ($p < 0.001$). Patients further from a RT facility were more likely to receive a mastectomy (OR = 1.45; 95% CI = 1.30 - 1.62).
Voti L, *et al.*	Florida, United States	Local stage female breast cancer patients (SEER) from July 1997 and December 2000.	Rurality index not specified, likely all urban participants.	Greater distance to a RT facility decreased RT use: OR decreased 3% per 5 mile increase in distance. Younger ages had increased utilisation of BCT, with the OR decreasing 1% per year increase in age.
Cetnar JP, *et al.*	Wisconsin, United States	Random selection of men with a confirmed diagnosis of prostate cancer in the Wisconsin Cancer Reporting System in 2004 with specified exclusions.	Mix of rural and urban setting. 95% of the population live within 15 miles of a hospital.	Rural patients were equally as likely to receive radiotherapy as their urban counterparts • Rural/urban setting OR = 1.01; 95% CI = 0.59 – 1.74 • Rural setting OR = 0.96; 95% CI = 0.52 – 1.77
Athas WF, *et al.*	New Mexico, United States	All cases of localised (SEER) breast cancer diagnosed between 1994 and 1995 in female residents of New Mexico, excluding Native American women due to lack of address.	Vast setting with large distances to travel between population districts with 12 facilities.	Lower likelihood of receiving RT post breast conserving surgery with increased travel distance. 51% living > 75miles from a facility received RT (OR = 0.26; 95% CI = 0.14-0.5) vs 82% living ≤50miles away (OR = 1.00).
Underhill C, *et al.*	All Australian states and territories except ACT	Staff self-administered cross-sectional survey administered between June and December 2005 to 161 RHAC. Responses completed by hospital manager, chemotherapy nurse, oncologist, or delegate (n=157).	Mixed urban and rural, classified under Australian Standard Geographical Classification (ASGC) Remoteness Areas (RAs).	46% of RT facilities were fully staffed with an average wait time of three weeks. The study indicated difficulties for patients and their families relating to travel and transport refunds. Shortages in the medical and radiation oncology field were identified.
Baldwin LM, *et al.*	8 states across the United States	Patients with a diagnosis of one of anal, rectal, lung, breast or cervical cancers through NCNN and SEER staging. Exclusion of male breast cancer. Years included: 2000-2004.	Mixture of rural (14,692) and urban (107,834) patients.	Older ages received less RT amongst all diagnoses. Breast cancer patients further from a RT facility had less RT utilisation compared with urban counterparts (62.1% vs 69.1%; $p \leq 0.001$). Other cancers demonstrated equal rural vs urban utilisation.
Boscoe FP, *et al.*	10 states across the United States	All early stage female breast cancer cases (SEER) from 2004 and 2006.	Mixture of settings: 73% 0-15km from RT facility, 5.4% 30-45km, <1% >100km from facility.	With further distance from a RT facility, rate of mastectomies increased (in the group >60km from surgery and <30km from RT, 42.2% received mastectomy rather than BCT; OR = 1.27). Opening of a new RT facility was associated with a reduction in mastectomy rates from 61% to 45%.
Williams MV, *et al.*	United Kingdom: England, Scotland, Wales, Northern Ireland	2504 RT patients who were newly commencing RT during the week of September 24, 2007.	Mix of urban and rural settings.	Variations were observed in wait times, access rates and dose fractionation across the UK. Deprivation (economic, social, and housing indices) affects access rates.
Baade PD, *et al.*	Queensland, Australia	Men with newly diagnosed prostate cancer residing in Queensland (Brisbane, Townsville, and Mackay). Data extracted from registry.	Mixture of regional and urban areas within Queensland.	RT utilisation with adjuvant androgen deprivation therapy increased with older age and greater distance from a RT facility. RT alone had greater utilisation in retired patients, those who were asymptomatic, had low Gleason scores/localised prostate cancer, or who had a smoking history. Prostatectomy results were ↑ in patients who lived closer to the RT facility.
Peipins LA *et al.*	Atlanta, Georgia metropolitan area, United States	Year 2000 Census data for all women ≥40 years old in specified counties.	Urban only with access to public transportation options. 18 RT facilities were geocoded.	Public transportation resulted in a travel time of 56 minutes vs private transport which took 8 minutes, though the distances were similar. Public transport remains a barrier to accessibility of RT.

References

[1] Soo J, French J, McGahan CE, Duncan G, Lengoc S. A retrospective study on accessibility of palliative radiation therapy in the management of prostate cancer in British Columbia. Journal of Radiotherapy in Practice. 2011;10(3):159-72.

[2] Aneja S, Yu JB. The impact of county-level radiation oncologist density on prostate cancer mortality in the United States. Prostate Cancer and Prostatic Diseases. 2012;15(4):391-6.

[3] Schroen AT, Brenin DR, Kelly MD, Knaus WA, Slingluff Jr 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.

[4] Voti L, Richardson LC, Reis IM, Fleming LE, MacKinnon J, Coebergh JWW. Treatment of local breast carcinoma in Florida: The role of the distance to radiation therapy facilities. Cancer. 2006;106(1):201-7.

[5] Bomford CK KI. Walter and Miller's textbook of radiotherapy: radiation physics, therapy and oncology. 6 ed. USA: Churchill Livingstone Elsevier Ltd; 2003.

[6] Khan F. The physics of radiation therapy. 3 ed. USA: Lippincott Williams &Wilkins; 2003.

[7] Cetnar JP, Hampton JM, Williamson AA, Downs T, Wang D, Owen JB, *et al.* Place of residence and primary treatment of prostate cancer: Examining trends in rural and nonrural areas in wisconsin. Urology. 2013;81(3):540-6.

[8] Athas WF, Adams-Cameron M, Hunt WC, Amir-Fazli A, Key CR. Travel distance to radiation therapy and receipt of radiotherapy following breast-conserving surgery. Journal of the National Cancer Institute. 2000;92(3):269-71.

[9] Underhill C, Bartel R, Goldstein D, Snodgrass H, Begbie S, Yates P, *et al.* Mapping oncology services in regional and rural Australia. Australian Journal of Rural Health. 2009;17(6):321-9.

[10] Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. British Medical Journal. 2009;339:b2535.

[11] Khan, Khalid S, Kunz R, Kleijnen J, Antes G. Five steps to conducting a systematic review. Journal of the Royal Society of Medicine. 2003;96(March 2003):118-21.

[12] Liamputtong P, editor. Research methods in health education Ch 18: Everything you wanted to know about systematic reviews. Sydney, NSW, Australia; 2010.

[13] Baldwin LM, Patel S, Andrilla CHA, Rosenblatt RA, Doescher MP. Receipt of recommended radiation therapy among rural and urban cancer patients. Cancer. 2012;118(20):5100-9.

[14] Boscoe FP, Johnson CJ, Henry KA, Goldberg DW, Shahabi K, Elkin EB *et al.* Geographic proximity to treatment for early stage breast cancer and likelihood of mastectomy. Breast. 2011;20(4):324-8.

[15] Williams MV, Drinkwater KJ. Geographical Variation in Radiotherapy Services Across the UK in 2007 and the Effect of Deprivation. Clinical Oncology. 2009;21(6):431-40.

[16] Baade P, Youlden DR, Gardiner RA, Ferguson M, Aitken JF, Yaxley J *et al.* Factors associated wth treatment received by men diagnosed with prostate cancer in Queensland, Australia. BJU International. 2012;110:712-9.

[17] Peipins LA, Graham S, Young R, Lewis B, Flanagan B. Racial disparities in travel time to radiotherapy facilities in the Atlanta metropolitan area. Social Science and Medicine. 2013;89:32-8.

[18] Delaney G, Jacob S, Featherstone C, Barton M. The role of radiotherapy in cancer treatment: Estimating optimal utilization from a review of evidence-based clinical guidelines. Cancer. 2005;104(6):1129-37.

[19] Mackillop WJ, Groome PA, Zhang-Solomons J, Zhou Y, Feldman-Stewart D, Paszat L *et al.* Does a centralized radiotherapy system provide adequate access to care? Journal of Clinical Oncology. 1997;15(3):1261-71.

[20] Sabesan S, Larkins S, Evans R, Varma S, Andrews A, Beuttner P *et al.* Telemedicine for rural cancer care in North Queensland: Bringing cancer care home. Australian Journal of Rural Health. 2012;20(5):259-64.

[21] Sabesan S, Simcox K, Marr I. Medical oncology clinics through videoconferencing: An acceptable telehealth model for rural patients and health workers. Internal Medicine Journal. 2012;42(7):780-5.

[22] Gauthier DM, Swigart VA. The contextual nature of decision making near the end of life: Hospice patients' perspectives. American Journal of Hospice and Palliative Medicine. 2003;20(2):121-8.

[23] Delaney G, Barton M, Jacob S. Estimation of an Optimal Radiotherapy Utilization Rate for Breast Carcinoma: A Review of the Evidence. Cancer. 2003;98(9):1977-86.

[24] Delaney G, Jacob S, Barton M. Estimating the optimal external-beam radiotherapy utilization rate for genitourinary malignancies. Cancer. 2005;103(3):462-73.

[25] Resnick MJ, Guzzo TJ, Cowan JE, Knight SJ, Carroll PR, Penson DF. Factors associated with satisfaction with prostate cancer care: Results from Cancer of the Prostate Strategic Urologic Research Endeavor (CaPSURE). BJU International. 2013;111(2):213-20.