Variation in the use of palliative radiotherapy at end of life: Examining demographic, clinical, health service, and geographic factors in a population-based study

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Abstract

Palliative radiotherapy (PRT) can improve quality of life for people dying of cancer. Variation in the delivery of PRT by factors unrelated to need may indicate that not all patients who may benefit from PRT receive it. In this study, 13,494 adults who died of cancer between 2000 and 2005 in Nova Scotia, Canada, were linked to radiotherapy records. Multivariate logistic regression was used to examine the relationships among demographic, clinical, service, and geographic variables, and PRT consultation and treatment. Among the decedents, 4188 (31.0%) received PRT consultation and 3032 (22.3%) treatment. PRT declined with increased travel time and community deprivation. Females, older persons, and nursing home residents also had lower PRT rates. Variations were observed by cancer site and previous oncology care. Variations in PRT use should be discussed with referring physicians, and improved means of access to PRT considered. Benchmarks for optimal rates of PRT are needed.

Keywords

Health services accessibility; palliative care; radiotherapy; rural health; socioeconomic factors

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Conflict of interest

The authors declare that they have no conflicts of interest.

Introduction

Palliative radiotherapy (PRT) plays an important role in the care of people dying of cancer^{1,2} through the palliation of symptoms such as pain, bleeding, and obstruction.^{3,4} Radiotherapy (RT) is cost-effective compared with other available palliative treatments,^{5–8} and is inversely correlated with hospital bed use at end of life.⁹

PRT is one form of palliative medicine that has the potential to improve quality of life for patients with advanced cancer. However, variation in the delivery of PRT associated with factors unrelated to patient need, such as lower socioeconomic status and longer distance to treatment, have been observed.^{10–12} This is despite the fact that in Canada, a universal, single-payer insurance system limits explicit financial barriers to care that have been identified in other countries.^{1,13,14} Surveys suggest that transportation to treatment centers may be a barrier to referral, particularly in rural areas.^{15,16}

Studies to date which have directly assessed PRT service use have been limited by crude measures of geographic and socioeconomic variables, and few markers of health services received. County of residence,¹⁰ straight-line distance from residence to treatment center,¹¹ and driving distance¹² have been used to measure geographic accessibility, while median household income was used to measure community socioeconomic status.^{10–12} This new study seeks to better understand factors affecting access to PRT through the use of improved measures of travel time and community deprivation, and by mapping results as a means of enhancing knowledge exchange with the goal of improving equity in access to quality care. Associations with nursing home residence, hospital as the place of death, and medical oncology consultation which were not available in our earlier study¹¹ have also been incorporated.

Methods

Study context and population

The province of Nova Scotia, Canada, has a total population of 913,462.¹⁷ During the time period of this study, RT was provided in the regional cancer centers located in the two major urban centers, Sydney and Halifax. These cities correspond to District Health Authorities (DHAs) 8 and 9, respectively. The study population is the 13,494 adults (20 years or older) who died between 2000 and 2005 in Nova Scotia with cancer as the underlying cause of death on their death certificate.

Sources of data and study variables

The Oncology Patient Information System includes all cancer diagnoses in the province reported in the cancer registry (CR), cancer deaths from Vital Statistics (VS) death certificates, and the provincial cancer center treatment database (TX). Date of birth, sex, and date of cancer diagnosis were obtained from the CR. Underlying cancer cause of death using the tenth revision of the International Classification of Diseases (ICD-10), date and place of death, and postal code of residence were from VS. Dates of RT, number of RT fractions, treatment intent (palliative or non-palliative), and medical oncology consultation were from

the TX. The two outcomes of interest were the probabilities of receiving a PRT consultation and treatment in the last 9 months of life.

Road travel time to the closest treatment center provides a more accurate measure of accessibility than straight-line distance.¹⁸ The longitudinal/latitudinal grid reference points of the two cancer centers and each decedent's residential postal code at death were captured in a geographic information system along with the boundaries of cities and towns, the road network, average vehicle speeds by road type, and urban/rural location. A travel time to PRT map of isochrones (lines of equal travel time) was then generated.

Deprivation indexes that incorporate income and other dimensions of community material and social deprivation have been used in the United Kingdom,^{19–21} and more recently adapted for Canada.^{22–24} The index employed in this study combines six census variables: (1) percent of adult population (aged 20 years or older) that completed high-school education; (2) ratio of employed adults to population; (3) median household income; (4) percent of population living alone; (5) percent of adults separated, divorced or widowed; and (6) percent lone parent families. The first three variables capture material deprivation, while the second three reflect social deprivation.²⁴ Deprivation was calculated by dissemination area (DA), the smallest census unit for which data are available. DA populations are typically between 400 and 700. In each DA, the six census variables were expressed as percentages, log-transformed if skewed, normalized by calculating z-scores and then summed. The resulting deprivation scores range from 1–5, with higher values indicating more deprived areas. Decedent residential postal codes were linked to DA deprivation scores using a Statistics Canada postal code conversion file.

Rural residence was defined by '0' as the second character in the postal code of residence. This indicates areas where there are no letter carriers (i.e. rural residents go to a post office or postal box to pick-up their mail).²⁵ Although it is based on Canadian postal geography and does not incorporate population counts directly, it acts as a proxy for population density, and compares closely with a map of urban areas based on accepted Statistics Canada census definitions.

Nursing home residence at the time of death was determined using the method of O'Brien et al.²⁶ Methods for other variables including PRT have been previously reported.¹¹ Cut-off points for inclusion of 2 years to 9 months for previous medical consultations and 9 months for PRT were determined using sensitivity analysis. ICD codes were grouped to describe major cancer sites and illustrate variation in use of PRT.

Statistical analysis

Rates of PRT consultation and treatment, as well as median travel time, deprivation scores, and percent rural residents, were tabulated by DHA. Deprivation scores, travel time, and percent receiving PRT by DHA were mapped to provide comparisons at the geographic unit used to plan health services.

Potential covariates were assessed for association with PRT consultation and treatment, with continuous variables categorized. Cut-points for survival time were determined by a

classification and regression tree (CART) analysis.²⁷ Backwards stepwise logistic regression was used to investigate the role of variables in determining whether or not a decedent received PRT consultation and treatment, controlling for the effects of other variables. Results are presented as odds ratios (ORs). Statistical significance was assessed through the likelihood ratio test statistic and using 95% confidence intervals (CIs). Since patients in Cumberland (DHA 5) may access health services in the neighboring province of New Brunswick, regression models were computed with and without these people. This sensitivity analysis showed that the resulting estimates were very similar, with no differences in the direction or statistical significance of effects. Therefore, the models presented herein include Cumberland residents.

Ethics approval

This research received approval from the Capital Health Research Ethics Board.

Results

Of the 13,494 people who died between 2000 and 2005, 4188 (31.0%) received a PRT consultation and 3032 (22.5%) received PRT treatment in the last 9 months of life. Among the study subjects, 53.4% were male and 29.0% were aged 80 years or older (Table 1). Younger decedents (20–59 years) had higher rates of PRT consultation (44.1%) and treatment (34.2%). The most common cancer diagnosis was lung (27.5%).

Across the cancer sites, PRT consultation and treatment were most commonly given to those dying from lung (49.4%, 37.3%), breast (35.4%, 31.5%), melanoma (51.8%, 39.5%), and prostate (30.4%, 27.6%) cancer. Those who survived 1.5–26 months after their cancer diagnosis had the highest PRT consultation and treatment rates (39.8%, 28.0%). Those surviving more than 26 months had PRT consultation rates (24.9%) similar to their treatment rate (22.5%). Those living less than 1.5 months after their cancer diagnosis had the lowest PRT consultation (13.8%) and treatment (5.6%) rates.

The 419 (3.1%) of decedents who had a previous medical oncology consultation had high rates of PRT consultation and treatment (78%, 72.6%). In contrast, the 968 (7.2%) decedents who lived in nursing homes at their time of death had low rates of PRT consultation and treatment (16.6%, 11.1%). The rates for those who died in hospital (31.9%, 22.9%) were close to the mean for all decedents (31.0%, 22.5%). The 2135 (15.8%) who had had previous RT had a PRT consultation rate (32.6%) close to their treatment rate (31.5%).

Rates of PRT consultation and treatment declined with increasing travel time. Deprivation was inversely associated with PRT: the least deprived quintile had the highest PRT rates (34.9%). Rural residents had slightly lower than average univariate PRT consultation and treatment rates (28.7%, 21%).

In Figure 1, deprivation scores mapped by DA show considerable variation within each DHA, for both urban (Halifax inset) and rural areas. Data for areas with low population counts are suppressed. Figure 2 shows isochrones of 1-h intervals for travel time to PRT and

circles representing PRT rates by DHA, visually demonstrating their geographic relationship.

Table 2 shows travel time, deprivation and rural population along with PRT rates for the nine DHAs ranked by median travel time. DHAs with longer travel time tended to have higher proportions of rural residents and median deprivation scores. An exception was Cape Breton (DHA 8) which has a short travel time, includes an RT treatment center that opened in late 1998 and a largely urban population, but the highest median deprivation score, and PRT consultation and treatment rates that are in the middle of the DHA rankings. The low PRT consultation and treatment rates in Cumberland (DHA 5) reflect patients accessing services in the neighboring province of New Brunswick. The Southwest region (DHA 2) had the longest travel times to treatment and relatively low rates of PRT consultation and treatment (24.1%, 18.2%). The highest consultation and treatment rates (37.7%, 27.0%) were in DHA 9, which has the largest and longest-standing RT center.

The univariate results for PRT consultations showed similar trends to those for treatment, with only a few exceptions (Table 3). Those with a diagnosis of head and neck cancer were twice as likely to have a consultation than to receive treatment, as were those with a survival time of less than 1.5 months. In contrast, those with previous RT had a PRT consultation rate that was not significantly different from the average (OR = 1.09; CI: 0.99–1.20) but a treatment rate significantly higher than average (OR = 1.76, CI: 1.59–1.94), reflecting their similar PRT consultation and treatment rates (32.5%, 31.6%) (Table 1). Year of death was not significantly associated with PRT consultation or treatment and so was not included.

In the multivariate analysis, the association of sex, age, cancer site, survival time, nursing home residence, and longer driving time with PRT consultation and treatment remained (Table 3). Increased odds were observed among those who had a previous medical oncologist consultation, though less than in the univariate results. In the univariate analysis, the PRT consultation rate was not associated with previous RT, but in the adjusted analysis previous RT was associated with lower odds of PRT consultation. For PRT treatment, the significant univariate findings for previous RT were no longer significant in multivariate analysis. Lower deprivation scores remained marginally significant. Death in hospital and rural residence were no longer significant in multivariate analysis (Table 3). The multivariate best-fit model did not include place of death, place of residence, and for PRT, previous RT.

Discussion

Demographic and clinical variables

Our finding that older decedents were less likely to receive PRT treatment and consultation is consistent with previous research both for PRT^{10,11} and for palliative care programs more broadly.²⁸ Sex and cancer site were controlled, so they cannot explain this association with age. We identified and controlled for nursing home residence, but even so the association with age remained. Other research carried out by our team showed that longer travel time may be a greater barrier for older people accessing palliative care programs.²⁹

The fact that those who survived less than 1.5 months had lower odds of receiving consultation may not be inequitable if this reflects little potential benefit or informed patient choice.³⁰ Research has shown lower rates of RT with increasing comorbidity.³¹ Those with short survival time from their cancer diagnosis to death may have more comorbid conditions, as may older decedents and nursing home residents.

Certain types of advanced cancer are more amenable to PRT treatment. Common sites of metastatic disease that are likely to benefit from PRT are bone (which frequently arise from lung, breast, and prostate cancers) and brain (which are most likely to develop in patients with breast and lung cancer).² High PRT rates for melanoma are expected, since radiotherapy can provide effective palliation and chemotherapy provides a less reliable response. The finding that a diagnosis of head and neck cancer was associated with a high rate of PRT consultation but not treatment may result from the high level of morbidity associated with cancers of the head and neck. Surgical salvage and radical or high-fraction RT retreatment may be more common than for other cancers, and PRT may not be advisable when the recurrence occurs in the same anatomic vicinity as previous RT.

In contrast to the greater-than-average differences between PRT consultation and treatment rates for head and neck cancer, and for persons surviving less than 1.5 months, sometimes the PRT consultation and treatment rates were very similar, for example among those who survived longer than 26 months (24.9%, 22.5%) or had previous RT (32.6%, 31.5%), and thus may reflect the appropriateness of these referrals. Survival longer than 26 months may reflect indolent disease or the availability of effective chemotherapy or hormonal treatment, and thus fewer symptoms requiring PRT.

It is difficult to determine whether observed rates of use by cancer site are appropriate, as no benchmarks exist for optimal PRT rates. However, the PRT consultation and treatment rates for the region with the highest rates, and that includes the largest cancer center, might be a benchmark for optimal care in the province (DHA 9: 37.7%, 27.0%).

Health service variables

Nursing home residents were half as likely to receive a PRT consultation, and when it did occur, equally unlikely to access treatment. Research is lacking on the relationship between nursing home residence and access to PRT, although there is evidence of low enrolment rates of nursing home residents in comprehensive palliative care programs.^{26,32–34} Our findings highlight the importance of ensuring that nursing home residents have access to comprehensive palliative services, including PRT where appropriate. Prior medical oncology consultation was associated with increased PRT rates. Visiting one specialist at a cancer center may be associated with an increased likelihood of referral to another type of specialist, which may reflect either need or ease of access.

After controlling for other variables, previous RT treatment was associated with a decreased likelihood of a PRT consultation. It could be that previous RT controlled the disease at the treatment site and so local progression was not a problem requiring palliation. It may also be that a further consultation with a patient known to the radiation oncologist may not have been coded as a new consultation for PRT. Still, the possibility exists that there may be lower

than optimal rates of referral to PRT after previous RT. Historically, there has been a misunderstanding by some physicians that radiotherapy can only be used once.

Most people would prefer to die at home rather than in hospital if the services they need can be made available to them.³⁵ Therefore, we wanted to determine if PRT rates continue to be associated with dying in hospital as we previously observed.³⁵ No association was observed in the multivariate analysis.

Geographic factors: Travel time, deprivation and rural residence

Living in a rural area was a predictor of lower rates of PRT consultation and treatment in the univariate analysis. However, in the multivariate analysis, rural residence was no longer significant due to colinearity with travel time and deprivation. Rural areas tend to be more materially deprived than urban centers and have longer travel times (Table 2).

The mapping of deprivation scores in Figure 1 shows that their variation within the DHAs is considerable, and deprivation is not just an issue in rural areas. Referring physicians and PRT providers should be sensitive to the possibility that deprivation might limit PRT access across all districts of the province.

The mapping of deprivation scores and travel times along with the PRT rates is a useful tool for knowledge exchange. This mapping is visually more effective than the tables of percentages and ORs used in the past to disseminate findings.¹¹

The inverse relationship between travel time and PRT was partially addressed after our previous paper¹¹ with the opening of the Sydney RT center (DHA 8) in late 1998 in northeast Nova Scotia. In 2005, toward the end of the time period of this latest study, a visiting radiation oncologist began providing consultation in the largest town in the Southwest district (DHA 2); patients still travel to Halifax for treatment. Further options for limiting the impact of travel and deprivation should be considered.

Other strategies to improve access

Various strategies may improve access and reduce barriers. Family physicians, particularly in areas with low PRT rates, need further education on when a PRT consultation would be advantageous.^{15,36} Providing visual presentations such as Figures 1 and 2 may help to further identify problems and promote dialogue on improving PRT access.

Recent meta-analyses and reviews of randomized clinical trials report that single-fraction radiotherapy provides equal efficacy of pain relief when compared with multiple-fraction radiotherapy.^{37–39} Single fractions are more convenient for people, can reduce the strain on radiotherapy resources, and are increasingly being used in other jurisdictions.⁴⁰ While in Nova Scotia multiple fractions were commonly used during the time period of this study, the Halifax treatment site has been exploring the implementation of rapid response radiotherapy to provide therapy soon after referral and streamline the process, minimizing the number of PRT clinic visits necessary to deliver treatment. When appropriate, the aim is to have consultation, treatment planning and the initiation of treatment all in one visit.

In conclusion, this analysis prompts questions about equity in PRT. Differences in PRT rates by cancer type and survival time may reflect differences in need and expected benefit. However, further study on differences in PRT by both age and nursing home residence is advised. Differences by travel time and deprivation scores appear unrelated to need, and indicate that not all people who might benefit from PRT actually receive it. Mapping patterns may enable dialogue on improving PRT access. Oncology services prior to the last months of life influence the receipt of PRT. The determination of optimal rates of PRT consultation and treatment is necessary.

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References

1. Fine PG. Palliative radiation therapy in end-of-life care: Evidence-based utilization. *Am J Hosp Palliat Care*. 2002; 19:166–170. [PubMed: 12026039]
2. Kirkbride P. The role of radiation therapy in palliative care. *J Palliat Care*. 1995; 11:19–26.
3. Nielsen OS. Present status of palliative radiotherapy. *Eur J Cancer*. 2002; 37(suppl 7):S279–288.
4. Hoegler D. Radiotherapy for palliation of symptoms in incurable cancer. *Curr Probl Cancer*. 1997; 21:135–183.
5. Konski A. Radiotherapy is a cost-effective palliative treatment for patients with bone metastasis from prostate cancer. *Int J Radiat Oncol Biol Phys*. 2004; 60:1373–1378. [PubMed: 15590167]
6. Barton MB, Jacob SA, Gebisky V. Utility-adjusted analysis of the cost of palliative radiotherapy for bone metastases. *Aust Radiol*. 2003; 47:274–278.
7. Samant RS, Roberts GH, Dunscombe PB. Case-costing of palliative radiotherapy: A Canadian single-institution perspective. *Curr Oncol*. 2002; 9:20–26.
8. Coy P, Schaafsma J, Schofield JA. The cost-effectiveness and cost-utility of high-dose palliative radiotherapy for advanced non-small-cell lung cancer. *Int J Radiat Oncol Biol Phys*. 2000; 48:1025–1033. [PubMed: 11072159]
9. Huang J, Boyd C, Tyldesley S, et al. Time spent in hospital in the last six months of life in patients who died of cancer in Ontario. *J Clin Oncol*. 2002; 20:1584–1592. [PubMed: 11896108]
10. Huang J, Zhou S, Groome P, et al. Factors affecting the use of palliative radiotherapy in Ontario. *J Clin Oncol*. 2001; 19:137–144. [PubMed: 11134206]
11. Johnston GM, Boyd CJ, Joseph P, et al. Variation in delivery of palliative radiotherapy to persons dying of cancer in Nova Scotia, 1994 to 1998. *J Clin Oncol*. 2001; 19:3323–3332. [PubMed: 11454879]
12. Danielson B, Winget M, Gao B, et al. Palliative radio-therapy for women with breast cancer. *Clin Oncol*. 2008; 20:506–512.
13. McCloskey SA, Tao ML, Rose CM, et al. National survey of perspectives of palliative radiation therapy: Role, barriers, and needs. *Cancer J*. 2007; 13:130–137. [PubMed: 17476142]
14. Lutz S, Spence C, Chow E, et al. Survey on use of palliative radiotherapy on hospice care. *J Clin Oncol*. 2004; 22:3581–3586. [PubMed: 15337808]
15. Samant RS, Fitzgibbon E, Meng J, et al. Barriers to palliative radiotherapy referral: A Canadian perspective. *Acta Oncol*. 2007; 46:659–663. [PubMed: 17562442]
16. Barnes EA, Parliament M, Hanson J, et al. Palliative radiotherapy for patients with bone metastases: Survey of primary care physicians. *Radiother Oncol*. 2003; 67:221–223. [PubMed: 12812854]
17. Statistics Canada. Community profiles, 3/07 update. 2006. <http://www.statcan.ca/bsolc/english/bsolc?catno=92-591-XWE>

18. O'Sullivan A, Shearer J. Using desktop GIS for the investigation of accessibility by public transport: An isochrone approach. *Int J Geogr Inf Sci.* 2000; 14:85–104.
19. Gilthorpe MS, Wilson RC. Rural/urban differences in the association between deprivation and healthcare utilisation. *Soc Sci Med.* 2003; 57:2055–2063. [PubMed: 14512237]
20. Morris R, Carstairs V. Which deprivation? A comparison of selected deprivation indexes. *J Publ Health Med.* 1991; 13:318–326.
21. Townsend, P., Phillimore, P., Beattie, A. Health and deprivation: Inequality and the north. London: Croom Helm; 1988.
22. Matheson FI, Moineddin R, Glazier RH. The weight of place: A multilevel analysis of gender, neighborhood material deprivation, and body mass index among Canadian adults. *Soc Sci Med.* 2008; 66:675–690. [PubMed: 18036712]
23. Bell N, Schuurman N, Oliver L, et al. Towards the construction of place-specific measures of deprivation: A case study from the Vancouver metropolitan area. *Can Geogr.* 2007; 51:444–461.
24. Pampalon R, Raymond G. A deprivation index for health and welfare planning in Quebec. *Chronic Dis Can.* 2000; 21:104–113. [PubMed: 11082346]
25. du Plessis V, Beshiri R, Bollman RD. Definitions of rural. *Rural small town anal bull.* 2001:3.
26. O'Brien MB, Johnston G, Gao J, et al. End-of-life care for nursing home residents dying from cancer in Nova Scotia, Canada, 2000–2003. *Support Care Cancer.* 2007; 15:1015–1021. [PubMed: 17277924]
27. Zhang, H., Singer, BH. Recursive partitioning and applications. 2. New York: Springer-Verlag; 2010.
28. Burt J, Raine R. The effect of age on referral to and use of specialist palliative care services in adult cancer patients: A systematic review. *Age Ageing.* 2006; 35:469–476. [PubMed: 16751635]
29. Burge F, Lawson B, Johnston G. A population-based study of age inequalities in access to palliative care among cancer patients. *Med Care.* 2008; 46:1203–1211. [PubMed: 19300309]
30. Asada Y. Vulnerability in palliative care: An application and extension of the risk chain model. *Progress Palliat Care.* 2010; 18:72–78.
31. Hayman JA, Abrahamse PH, Lakhani I, et al. Use of palliative radiotherapy among patients with metastatic non-small-cell lung cancer. *Int J Radiat Oncol Biol Phys.* 2007; 69:1001–1007. [PubMed: 17689029]
32. Burge FI, Johnston G, Lawson B, et al. Population-based trends in referral of the elderly to a comprehensive palliative care programme. *Palliat Med.* 2002; 16:255–256. [PubMed: 12047004]
33. Jordhøy MS, Saltvedt I, Fayers P, et al. Which cancer patients die in nursing homes? Quality of life, medical and sociodemographic characteristics. *Palliat Med.* 2003; 17:433–444. [PubMed: 12882262]
34. Rosenwax LK, McNamara BA. Who receives specialist palliative care in Western Australia – and who misses out. *Palliat Med.* 2006; 20:439–445. [PubMed: 16875115]
35. Burge F, Lawson B, Johnston G. Trends in the place of death of cancer patients, 1992–1997. *CMAJ.* 2003; 168:265–270. [PubMed: 12566330]
36. Samant RS, Fitzgibbon E, Meng J, et al. Family physicians' perspectives regarding palliative radiotherapy. *Radiother Oncol.* 2006; 78:101–106. [PubMed: 16330118]
37. Chow E, Harris K, Fan G, et al. Palliative radiotherapy trials for bone metastases: A systematic review. *J Clin Oncol.* 2007; 25:1423–1436. [PubMed: 17416863]
38. Sze WM, Shelley MD, Helds I, et al. Palliation of meta-static bone pain: Single fraction versus multifraction radiotherapy – A systematic review of randomised trials. *Clin Oncol (R Coll Radiol).* 2003; 15:345–352. [PubMed: 14524489]
39. Yarnold JR. 8 gy single fraction radiotherapy for the treatment of metastatic skeletal pain: Randomised comparison with a multifraction schedule over 12 months of patient follow-up. *Radiother Oncol.* 1999; 52:111–121. [PubMed: 10577696]
40. Bradley NME, Husted J, Sey MSL, et al. Did the pattern of practice in the prescription of palliative radiotherapy for the treatment of uncomplicated bone metastases change between 1999 and 2005 at the rapid response radiotherapy program? *Clin Oncol (R Coll Radiol).* 2008; 20:327–336. [PubMed: 18276125]

Figure 1.
Deprivation score by dissemination area in District Health Authorities (DHAs) 1–9.
*The names of DHAs 1–9 are given in Table 2.

Figure 2.

Travel time and the percentage of cancer decedents receiving PRT in District Health Authorities (DHAs) 1–9.

*The names of DHAs 1–9 are given in Table 2.

Table 1Description of the study population, *n* (%)

	Total Population (n = 13,494)	Received PRT Consultation (n = 4188)	Received PRT Treatment (n = 3032)
Sex			
Female	6292 (46.6)	1815 (28.9)	1335 (21.2)
Male	7202 (53.4)	2373 (33.0)	1697 (23.6)
Age (years)			
20–59	2495 (18.5)	1100 (44.1)	854 (34.2)
60–69	2937 (21.8)	1183 (40.3)	883 (30.1)
70–79	4151 (30.8)	1295 (31.2)	896 (21.6)
80+	3911 (29.0)	610 (15.6)	399 (10.2)
Year of death			
2000	2174 (16.1)	694 (31.9)	491 (22.6)
2001	2143 (15.9)	679 (31.7)	478 (22.3)
2002	2256 (16.7)	661 (29.3)	487 (21.6)
2003	2302 (17.1)	702 (30.5)	508 (22.1)
2004	2334 (17.3)	732 (31.4)	530 (22.7)
2005	2285 (16.9)	720 (31.5)	538 (23.5)
Major cancer site (ICD-10 codes)			
Breast (C54)	1069 (7.9)	378 (35.4)	337 (31.5)
Colorectal (C18–C21)	1886 (14.0)	265 (14.1)	186 (9.9)
Head and neck (C00–14, C30–31)	284 (2.1)	125 (44.0)	52 (18.3)
Hematological (C42,C77)	1029 (7.6)	145 (14.1)	106 (10.3)
Lung (C33,C34)	3714 (27.5)	1835 (49.4)	1384 (37.3)
Melanoma (C44)	195 (1.5)	101 (51.8)	77 (39.5)
Pancreas (C25)	638 (4.7)	24 (3.8)	11 (1.7)
Prostate (C61)	767 (5.7)	233 (30.4)	212 (27.6)
Unknown Primary (C77–80)	827 (6.1)	138 (16.7)	93 (11.3)
Other *	3085 (22.9)	944 (30.6)	574 (18.6)
Survival time (months)			
<1.5	2422 (18.0)	333 (13.8)	135 (5.6)
1.5–26	7404 (54.9)	2943 (39.8)	2072 (28.0)
26+	3668 (27.2)	912 (24.9)	825 (22.5)
Medical oncology consultation (9–24 months before death)	419 (3.1)	327 (78.0)	304 (72.6)
Previous radiotherapy (in preceding 5 years)	2135 (15.8)	696 (32.6)	673 (31.5)
Died in hospital	9691 (71.8)	3092 (31.9)	2222 (22.9)
Resided in nursing home	968 (7.2)	161 (16.6)	107 (11.1)
Travel Time (minutes)			
0–<30	5988 (44.4)	2126 (35.5)	1507 (25.2)
30–<60	1118 (8.3)	386 (34.7)	275 (24.7)
60–<120	4230 (31.4)	1225 (28.9)	905 (21.4)

	Total Population (n = 13,494)	Received PRT Consultation (n = 4188)	Received PRT Treatment (n = 3032)
120–214	2158 (16.0)	451 (20.9)	345 (15.9)
Deprivation (quintiles)			
1 (least deprived)	2205 (16.3)	770 (34.9)	567 (25.7)
2	2263 (16.8)	730 (32.3)	540 (23.9)
3	2470 (18.3)	775 (31.4)	570 (23.1)
4	2917 (21.6)	867 (29.7)	612 (21.0)
5 (most deprived)	3639 (27.0)	1046 (28.7)	743 (20.4)
Rural resident	5483 (40.6)	1573 (28.7)	1153 (21.0)

* 'Other' includes all invasive cancer sites not specified above. These start with 'C' in ICD-10.

Table 2

Characteristics of the study population by DHA (*n* = 13,494)

Name	N (%)	Median travel time (minutes)	Median deprivation score	% Rural residents	% PRT Consultation	% PRT Treatment
Capital Health (DHA 9)	4695 (34.8)	15.5	2	15.0	37.7	27.0
Cape Breton (DHA 8)	2357 (17.5)	26.3	5	19.4	30.3	20.8
Colchester East Hants (DHA 4)	965 (7.2)	69.6	3	46.9	29.2	20.5
South Shore (DHA 1)	1066 (7.9)	76.9	3	77.4	31.5	25.4
Annapolis Valley (DHA 3)	1188 (8.8)	91.6	3	72.9	28.7	21.7
Pictou County (DHA 6)	780 (5.8)	108.3	4	62.8	26.5	19.2
Guyshorough (DHA 7)	746 (5.5)	113.2	4	65.6	25.2	18.9
Cumberland (DHA 5)	628 (4.7)	125.9	4	60.0	14.7	10.4
South West (DHA 2)	1069 (7.9)	175.5	4	77.2	24.1	18.2

Table 3

Odds of PRT consultation and treatment in last 9 months of life

Variable	PRT Consultation		PRT Treatment	
	Univariate	Adjusted	Univariate	Adjusted
	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)
Sex				
M (vs. F)	1.21 (1.13, 1.30)	1.19 (1.09, 1.30)	1.14 (1.06, 1.24)	1.18 (1.06, 1.30)
Age (vs. 80+)				
20–59	4.27 (3.80, 4.80)	3.88 (3.40, 4.43)	4.58 (4.01, 5.23)	3.88 (3.35, 4.49)
60–69	3.65 (3.26, 4.09)	3.08 (2.71, 3.50)	3.78 (3.32, 4.31)	3.07 (2.66, 3.54)
70–79	2.45 (2.20, 2.73)	2.16 (1.92, 2.43)	2.42 (2.13, 2.75)	2.08 (1.81, 2.38)
Major cancer site (vs. lung) *				
Breast	0.56 (0.49, 0.64)	0.75 (0.63, 0.89)	0.78 (0.67, 0.90)	0.76 (0.63, 0.91)
Colorectal	0.17 (0.14, 0.19)	0.16 (0.14, 0.19)	0.18 (0.16, 0.22)	0.17 (0.15, 0.21)
Head and neck	0.81 (0.63, 1.03)	0.76 (0.59, 0.99)	0.38 (0.28, 0.51)	0.29 (0.21, 0.40)
Hematological	0.17 (0.14, 0.20)	0.16 (0.13, 0.20)	0.19 (0.16, 0.24)	0.19 (0.15, 0.24)
Melanoma	1.10 (0.82, 1.47)	1.14 (0.83, 1.56)	1.10 (0.82, 1.48)	0.95 (0.69, 1.31)
Pancreas	0.04 (0.03, 0.06)	0.03 (0.02, 0.05)	0.03 (0.02, 0.05)	0.03 (0.02, 0.05)
Prostate	0.45 (0.38, 0.53)	0.68 (0.56, 0.83)	0.64 (0.54, 0.76)	0.82 (0.67, 1.00)
Unknown Primary	0.21 (0.17, 0.25)	0.24 (0.19, 0.29)	0.21 (0.17, 0.27)	0.29 (0.23, 0.37)
Other	0.45 (0.41, 0.50)	0.42 (0.38, 0.47)	0.38 (0.34, 0.43)	0.34 (0.31, 0.39)
Survival time, months (vs. 26+)				
<1.5	0.48 (0.42, 0.55)	0.43 (0.37, 0.51)	0.20 (0.17, 0.25)	0.20 (0.16, 0.25)
1.5–26	1.99 (1.83, 2.18)	1.74 (1.56, 1.94)	1.34 (1.22, 1.47)	1.18 (1.06, 1.33)
Medical oncology consultation				
Received (vs. not received)	8.48 (6.71, 10.72)	3.74 (2.89, 4.84)	10.03 (8.06, 12.48)	4.44 (3.50, 5.62)
Previous radiotherapy				
Received (vs. not received)	1.09 (0.99, 1.20)	0.61 (0.55, 0.69)	1.76 (1.59, 1.94)	–
Place of death				
Hospital (vs. other)	1.16 (1.07, 1.26)	–	1.10 (1.00, 1.20)	–
Place of residence				
Nursing Home (vs. other)	0.42 (0.35, 0.50)	0.56 (0.46, 0.68)	0.41 (0.33, 0.50)	0.55 (0.44, 0.68)
Travel time (hours) Deprivation (vs. 5)	0.77 (0.74, 0.80)	0.72 (0.68, 0.76)	0.83 (0.79, 0.87)	0.84 (0.79, 0.88)
1	1.33 (1.19, 1.49)	1.13 (0.99, 1.29)	1.35 (1.19, 1.53)	1.17 (1.01, 1.34)
2	1.18 (1.05, 1.32)	1.15 (1.01, 1.31)	1.22 (1.08, 1.39)	1.20 (1.04, 1.38)
3	1.13 (1.01, 1.27)	1.20 (1.06, 1.37)	1.17 (1.03, 1.32)	1.22 (1.06, 1.40)
4	1.05 (0.94, 1.17)	1.10 (0.98, 1.25)	1.03 (0.92, 1.17)	1.09 (0.95, 1.24)
Place of residence				
Urban (vs rural)	1.20 (1.12, 1.30)	–	1.15 (1.06, 1.25)	–

* ICD-10 codes are listed in Table 1.