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Travel distance and season of diagnosis affect treatment choices for women with early-stage breast cancer in a predominantly rural population (United States)

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Abstract

Objective Current standards of care for early-stage breast cancer include either breast-conserving surgery (BCS) with post-operative radiation or mastectomy. A variety of factors influence the type of treatment chosen. In northern, rural areas, daily travel for radiation can be difficult in winter. We investigated whether proximity to a radiation treatment facility (RTF) and season of diagnosis affected treatment choice for New Hampshire women with early-stage breast cancer.

Methods Using a population-based cancer registry, we identified all women residents of New Hampshire diagnosed with stage I or II breast cancer during 1998–2000. We assessed factors influencing treatment choices using multivariate logistic regression.

Results New Hampshire women with early-stage breast cancer were less likely to choose BCS if they live further from a RTF ($P < 0.001$). Of those electing BCS, radiation was less likely to be used by women living >20 miles from a RTF ($P = 0.002$) and those whose diagnosis was made during winter ($P = 0.031$).

Conclusion Our findings indicate that a substantial fraction of women with early-stage breast cancer in New Hampshire receive suboptimal treatment by forgoing radiation because of the difficulty traveling for radiation in winter. Future treatment planning strategies should consider these barriers to care in cold rural regions.

Keywords Breast cancer · Breast-conserving surgery · Geographic factors · Radiotherapy · Season

Introduction

Most women with early-stage breast cancer have a choice between two roughly equivalent treatment options: either breast conserving surgery (BCS) followed by radiation therapy (RT), or a modified radical mastectomy (MRM) [1, 2]. Both approaches have been shown in randomized clinical trials to result in similar long-term survival [3–6]. BCS without subsequent radiation carries an increased risk of local recurrence, and current guidelines recommend against this approach [2].

Previous studies have shown that the use of BCS and post-operative radiation is influenced by age [7–10], psycho-social factors [11–13], and hospital characteristics [14–17]. Ease of access to treatment may also affect treatment choice for rural patients with cancer [12, 18–21]. Geographic factors, particularly proximity of treatment facilities to patients' residence may play a role in treatment choice for rural patients with cancer. In a study of lung cancer patients in New Hampshire and Vermont, Greenberg et al. [18, 19] found that patients living further from a radiation therapy unit were less likely to receive radiation for their disease.

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We assessed whether distance from a radiation treatment facility (RTF) and season of diagnosis affected choice of treatment among women with early stage breast cancer in New Hampshire, a state with a largely rural population [22] and which is noted for severe winter weather [23].

Materials and methods

Data collection

We identified women for study from the population-based New Hampshire State Cancer Registry (NHSCR). This statewide cancer surveillance program collects information on cases of *in situ* and invasive cancers seen and/or treated in the 27 hospitals and by other health care providers in New Hampshire and also receives data for state residents with cancer who are cared for in the three adjacent New England states, as well as Florida, New York, and other states with cancer registries. The quality of case reports and the case completeness of data meet standards set by the North American Association of Central Cancer Registries (NAACCR) [24]. Our study population consisted of all women residents of New Hampshire who were diagnosed between 1 January 1998 and 31 December 2001 with breast cancer histology and morphology codes 8500–8543 defined by ICD-O-2 for cases diagnosed in 1998–2000 and ICD-O-3 for cases diagnosed in year 2001. We excluded women diagnosed at autopsy or identified only through death certificates. The American Joint Commission on Cancer (AJCC) staging group was used to classify cases by stage. Each case had either a pathologic or clinical AJCC stage group, and these were pooled into a combined stage group. Cases were defined as early-stage if the AJCC stage group was I–IIB (Fig. 1).

The treatment types studied were first course of surgery and radiation. Surgical treatment was categorized as BCS and non-BCS, regardless of whether axillary lymph node dissection was performed. BCS included partial mastectomy, nipple resection, lumpectomy, re-excision, wedge resection, tylectomy, quadrantectomy, and segmental and subcutaneous mastectomies. Non-BCS consisted of total/simple, radical and extended mastectomies. Only the most definitive surgical treatment within each type was considered. For example, if a patient had both BCS and non-BCS, the non-BCS was considered to be the most definitive. We collected information about possible predictors of treatment choices, including patient residence, date of diagnosis, marital status, age, presence of multiple primary cancers, and tumor stage and size. We classified the season of diagnosis as winter (December–February) or non-winter (March–November). Marital status was defined as married or unmarried (single, separated, divorced, or widowed). We defined women as having their first primary cancer (sequence 00 or 01) or multiple primaries (sequence 02–04) based on data in the registry.

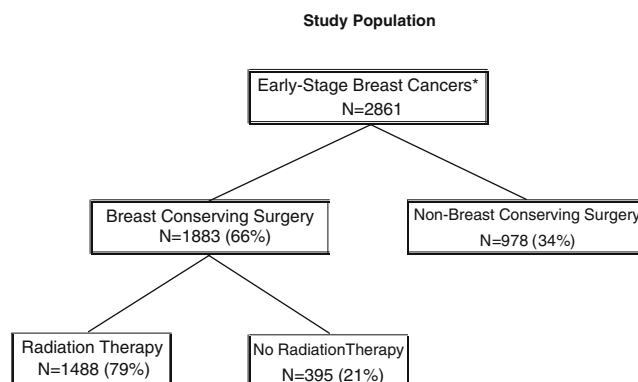### Proximity of residence to radiation therapy facilities

We identified all facilities providing radiation treatment in New Hampshire (5), Maine (5), Massachusetts (30) and Vermont (3) during the years 1998–2001 [25–28]. Each facility and the addresses of the patients were geocoded by Geographic Data Technology (GDT) of Lebanon, NH to an exact street address (*n* = 2292; 80.1%), or to the zip code centroid if only a post office box or rural route address (*n* = 569; 19.9%) was provided. The shortest straight-line distance to a RTF was estimated for each case [29]. Of the 38 candidate RTFs, 9 were the nearest to at least one patient in the study (5 in NH, 3 in MA, and 1 in ME).

Statistical analysis

We performed simple descriptive analyses for all variables as well as tabulations of their treatment choices. We used univariate analyses (chi-square) to test the variables for statistical significance in relation to BCS and post-BCS RT. We then calculated odds ratios and 95% confidence intervals with multiple logistic regression to identify factors that determine treatment choices for women with early-stage

Fig. 1 Choice of treatment among New Hampshire women diagnosed with early-stage breast cancer in 1998–2001. *Includes only New Hampshire women identified as having had surgical treatment

Study Population

Early-Stage Breast Cancers*
N=2861

Breast Conserving Surgery
N=1883 (66%)

Non-Breast Conserving Surgery
N=978 (34%)

Radiation Therapy
N=1488 (79%)

No RadiationTherapy
N=395 (21%)

breast cancer. Statistical analyses were performed using SPSS for Windows version 11 [30] and SAS statistical software [31].

Approval for the study of human subjects

This study was reviewed and approved by the Institutional Review Boards of Dartmouth College and the University of New Hampshire. Authorization was also granted by the State of New Hampshire, Department of Health and Human Services, Office of Community and Public Health, Bureau of Health Statistics and Data Management.

Results

The mean age of patients was 61 years (range 24–101). The mean distance between patient residence and the nearest RTF was 15.1 miles (range 0.1–89.9; median 13.9). Almost one quarter of patients lived ≥20 miles from the nearest RTF. Of the 1,883 (65.8%) women who were

treated with BCS, 79% received post-operative RT. Of the 978 (34.2%) women who had non-BCS, 17.8% also had RT. Overall, 1,662 women (58.1%) had RT as part of their initial therapy.

In univariate analyses the shortest distance to a RTF ($P \leq 0.001$), smaller tumor size ($P \leq 0.001$), lower stage ($P \leq 0.001$), first primary cancer ($P \leq 0.001$), and age 75 or older ($P = 0.001$) were all predictors of women undergoing BCS. Diagnosis in the winter ($P = 0.740$) and marital status ($P = 0.188$) were unrelated to the choice of BCS. Even so, we included these two variables in our multivariate regression analysis given their relevance to this study.

In the multivariate model, we confirmed that women were less likely to have BCS with increasing distance from residence to RTF ($P < 0.001$), higher stage disease ($P \leq 0.001$), increasing age ($P = 0.003$) or previous primary cancer (OR = 0.56, 95% confidence interval [CI] 0.45–0.71). Diagnosis in the winter ($P = 0.907$) and marital status ($P = 0.551$) remained unrelated to the choice of BCS (Table 1). Interactions between distance and the patient's

Table 1 Factors predicting BCS in 2795 New Hampshire women diagnosed with early-stage breast cancer in 1998–2001

	Total		BCS		Non-BCS		Adjusted OR (95% CI)[a]	p value
	No.	%	No.	%	No.	%		
Age at diagnosis								0.003
≤44	349	100.0	219	62.8	130	37.2	1.00	
45–54	670	100.0	457	68.2	213	31.8	1.11 (0.83–1.47)	0.480
55–64	598	100.0	427	71.4	171	28.6	1.30 (0.97–1.74)	0.082
65–74	637	100.0	402	63.1	235	36.9	0.83 (0.62–1.10)	0.195
≥75	541	100.0	337	62.3	204	37.7	0.86 (0.64–1.17)	0.347
Marital status[b]								
Married	1,776	100.0	1,190	67.0	586	33.0	1.00	
Not married	1,019	100.0	652	64.0	367	36.0	0.95 (0.79–1.13)	0.551
Primary sequence								
1st primary	2,429	100.0	1,635	67.3	794	32.7	1.00	
Subsequent primary	366	100.0	207	56.6	159	43.4	0.56 (0.45–0.71)	<0.001
Distance (mi.)								<0.001
0 to <20	2,089	100.0	1,426	68.3	663	31.7	1.00	
20 to <40	546	100.0	324	59.3	222	40.7	0.65 (0.53–0.79)	<0.001
40 to <60	130	100.0	79	60.8	51	39.2	0.77 (0.52–1.12)	0.176
≥60	30	100.0	13	43.3	17	56.7	0.31 (0.15–0.65)	0.002
Time of Year—Dx								
Non-winter	2,103	100.0	1,388	66.0	715	34.0	1.00	
Winter	692	100.0	454	65.6	238	34.4	1.01 (0.84–1.22)	0.907
Tumor size (cm)[b]								0.133
<1	669	100.0	486	72.6	183	27.4	1.00	
1 to <2	1,213	100.0	863	71.1	350	28.9	1.01 (0.81–1.26)	0.915
2 to <5	858	100.0	472	55.0	386	45.0	0.87 (0.65–1.17)	0.370
≥5	55	100.0	21	38.2	34	61.8	0.49 (0.26–0.92)	0.027
Stage at Dx								<0.001
I	1,700	100.0	1,244	73.2	456	26.8	1.00	
IIA	747	100.0	451	60.4	296	39.6	0.57 (0.45–0.72)	<0.001
IIB	348	100.0	147	42.2	201	57.8	0.28 (0.20–0.39)	<0.001

Note: In this analysis there was no significant interaction between the distance variable and the patient's age

[a]Odds ratios (OR) and 95% confidence intervals (CI) calculated using multiple logistic regression analysis, with all variables included

[b]Cases with unknown marital status ($n = 58$) and unknown tumor size ($n = 8$) excluded for the logistic regression model

age, and distance and winter diagnosis were not significant predictors in the model.

Following BCS, 395 women did not have RT; among this group, 22% ($n = 87$) had adjuvant chemotherapy, and 23% ($n = 90$) had adjuvant hormonal therapy. Univariate analysis showed that post-BCS RT was less likely in women diagnosed in the winter ($P = 0.019$) and those living further from the RTF ($P < 0.001$). Married women and women with no history of were also less likely to have RT ($P < 0.001$). Among women choosing BCS, stage did not affect whether they defaulted from RT ($P = 0.962$).

Using the same variables, we developed a multivariate logistic regression model for women who had BCS (Table 2). Patients were less likely to have radiation after BCS with increasing distance from residence to RTF ($P = 0.002$); diagnosis in winter months (OR = 0.75, 95% CI 0.57–0.97); age ≥75 (OR = 0.41, 95% CI 0.27–0.63); unmarried status (OR = 0.65, 95% CI 0.50–0.83); previous primary cancer (OR = 0.60, 95% CI 0.43–0.84), or tumor size 2–5 cm (OR = 0.76, 95% CI 0.50–1.17). There was no

statistically significant interaction between distance and age or distance and winter diagnosis.

Discussion

Our study confirms previous findings that the choice of BCS may be influenced by the distance a patient lives from the nearest RTF [12, 20, 21]. We also found that, among women treated with BCS, those diagnosed during the winter months and those living more than 20 miles from a RTF were less likely to receive post-operative radiation. The use of BCS without radiation may put women at increased risk of recurrence [6] and lower survival [32]. However, the choice of treatment may not be completely clear-cut, especially for women over 70 who also receive adjuvant treatment [33–35].

One previous report, based on older women in 10 northern states, assessed the effects of season on therapy choice in breast cancer and noted no association overall

Table 2 Factors predicting RT following BCS in 1842 New Hampshire women with early-stage breast cancer in 1998–2001

	Total		RT		No RT		Adjusted OR (95% CI)[a]	P value
	No.	%	No.	%	No.	%		
Age at diagnosis								<0.001
≤44	219	100.0	178	81.3	41	18.7	1.00	
45–54	457	100.0	393	86.0	64	14.0	1.40 (0.90–2.18)	0.131
55–64	427	100.0	364	85.2	63	14.8	1.41 (0.90–2.19)	0.131
65–74	402	100.0	330	82.1	72	17.9	1.17 (0.75–1.82)	0.483
≥75	337	100.0	198	58.8	139	41.2	0.41 (0.27–0.63)	<0.001
Marital status[b]								
Married	1,190	100.0	997	83.8	193	16.2	1.00	
Not married	652	100.0	466	71.5	186	28.5	0.65 (0.50–0.83)	0.001
Primary sequence								
1st primary	1,635	100.0	1,322	80.9	313	19.1	1.00	
Subsequent primary	207	100.0	141	68.1	66	31.9	0.60 (0.43–0.84)	0.003
Distance (mi.)								0.002
0 to <20	1,426	100.0	1,156	81.1	270	18.9	1.00	
20 to <40	324	100.0	246	75.9	78	24.1	0.71 (0.52–0.96)	0.025
40 to <60	79	100.0	55	69.6	24	30.4	0.51 (0.30–0.87)	0.013
≥60	13	100.0	6	46.2	7	53.8	0.24 (0.07–0.78)	0.017
Time of Year—Dx								
Non-winter	1,388	100.0	1,119	80.6	269	19.4	1.00	
Winter	454	100.0	344	75.8	110	24.2	0.75 (0.57–0.97)	0.031
Tumor size (cm)[b]								0.002
<1	486	100.0	377	77.6	109	22.4	1.00	
1 to <2	863	100.0	714	82.7	149	17.3	1.47 (1.10–1.97)	0.010
2 to <5	472	100.0	355	75.2	117	24.8	0.76 (0.50–1.17)	0.212
≥5	21	100.0	17	81.0	4	19.0	1.13 (0.34–3.78)	0.839
Stage at Dx								0.542
I	1,244	100.0	990	79.6	254	20.4	1.00	
IIA	451	100.0	356	78.9	95	21.1	1.15 (0.80–1.66)	0.454
IIB	147	100.0	117	79.6	30	20.4	1.36 (0.78–2.38)	0.279

Note: In this analysis there was no significant interaction between the distance variable and the patient's age

[a] Odds ratios (OR) and 95% confidence intervals (CI) calculated using multiple logistic regression analysis, with all variables included

[b] Cases with unknown marital status ($n = 37$) and unknown tumor size ($n = 4$) excluded for the logistic regression model

between season and treatment received [36]. However, in three of these states (New Hampshire, Vermont, and South Dakota), the proportions of women having BCS were substantially lower in winter than summer. The effect of season on choice of RT in these three states was not specified. Another study by Greenberg et al. reported that New Hampshire and Vermont lung cancer patients diagnosed in January and February were more likely to be referred to a university cancer center for treatment, and that referral was more likely in winter only if the patient lived within 25 miles of a cancer center [19]. Possible reasons for the decreased use of BCS and/or RT among early-stage breast cancer patients living further from a RTF include women's perceived access to care [20], regional practice patterns [21], access to transportation [36], and socioeconomic status [37].

A strength of our study was its use of a large population-based sample from the New Hampshire State Cancer Registry. However, we did not consider other types of treatment (i.e. axillary lymph node dissections, chemotherapy, and hormones), which in conjunction with certain clinical indicators, are all incorporated into the treatment guidelines. Additional limitations of the study relate to the procedures used by NHSCR to collect data. Most cases are reported to the registry within 6 months of diagnosis. Because the stage of cancers is generally determined at the time of the most definitive surgery, we would have misclassified stage if additional staging information was obtained after surgery. It has been reported that RT information may be incomplete in central registries [7, 38]. We would have misclassified the use of radiation if there was a significant delay before the course of radiation was given, for example, if patients in remote locations diagnosed during winter preferred to defer their treatment until spring.

Our estimate of straight-line distance to the nearest RTF only approximates the true travel distance, and estimates based on post office boxes addresses also entail some misclassification. A more precise representation of distance-related barriers to health care might be the travel time, which may reflect road quality. Future studies to confirm our findings might be to investigate travel time, which would also be a useful measure of access to healthcare. It is also possible that distance to treatment represents other factors that might vary by region and affect treatment choices, such as employment or income. Our database did not include the individual level variables that might have clarified this issue. Finally, it has been shown that women in rural areas tend to be diagnosed with breast cancer at a later stage. These women would be under-represented in a study of early-stage breast cancer such as ours [39].

In conclusion, early-stage breast cancer treatment is influenced by several factors; in New Hampshire, barriers to care include distance to nearest RTF and season of diagnosis. Women living more than 20 miles from a radiation treatment facility are not only less likely to have breast conserving surgery, but, if they do so, they are significantly less likely to receive post-operative radiation that would reduce their risk of recurrence. Of those electing BCS, a substantial fraction appear to forgo radiation because of the difficulty traveling during winter.

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