Disparities in the Initial Local Treatment of Older Women with Early-Stage Breast Cancer: A Population-Based Study

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Abstract

Background: Although breast cancer is most prevalent among older women, the majority are diagnosed at an early stage. When diagnosed at an early stage, women have the option of breast-conserving surgery (BCS) plus radiation therapy (RT) or mastectomy for the treatment of early-stage breast cancer (ESBC). Omission of RT when receiving BCS increases the risk for recurrence and poor survival. Yet, a small subset of older women may omit RT after BCS. This study examines the current patterns of local treatment for ESBC among older women.

Methods: This study conducted a retrospective observational analysis using the Surveillance, Epidemiology, and End Results (SEER)-Medicare linked dataset of women age ≥ 66 diagnosed with stage I-II breast cancer in 2003–2009. SEER-Medicare data was additionally linked with data from the Area Resource File (ARF) to examine the association between area-level healthcare resources and treatment. Two logistic regression models were used to estimate how study factors were associated with receiving (1) BCS versus BCS+RT and (2) Mastectomy versus BCS+RT. A stratified analysis was also conducted among women aged < 70 years.

Results: Among 45,924 patients, 55% received BCS+RT, 23% received mastectomy, and 22% received BCS only. Women of increasing age, comorbidity, primary care provider visits, stage II disease, and nonwhite race were more likely to have mastectomy or BCS only, than BCS+RT. Women diagnosed in 2004–2006, treated by an oncology surgeon, residing in metro areas, areas of greater education and income, were less likely to receive mastectomy or BCS only, than BCS+RT. While women aged < 70 years were more likely to receive BCS+RT, socioeconomic and physician specialties were associated with receiving BCS only.

Conclusions: Over half of older women with ESBC initially receive BCS+RT. The likelihood for mastectomy and BCS only increases with age, comorbidity, and vulnerable socio-demographic characteristics. Findings demonstrate continued treatment disparities among certain vulnerable populations.

Keywords: breast cancer, early-stage, treatment, elderly

Introduction

BREAST CONSERVING SURGERY (BCS) followed by radiation therapy (RT) is an equally effective local treatment for long-term survival of invasive early-stage breast cancer (ESBC), as is mastectomy,^{1–3} and is the preferred choice of local treatment, with $\sim 60\%$ or more women receiving BCS plus RT (BCS+RT).^{4,5} Treatment guidelines allow older women, age ≥ 70 years, stage I, estrogen receptor (ER) positive, and taking tamoxifen, to omit RT following BCS, and recommend RT for all other women undergoing BCS.⁶ RT

omission is associated with short-term treatment failure, and consequently, mastectomy, in addition to an increased risk of recurrence and breast cancer mortality.^{7–13} Unfortunately, a substantial number of clinically eligible older women do not receive RT following BCS, and a greater number may initially be treated with mastectomy, than younger women.^{7,11,14,15}

Following publication of the CALGB trial study results,¹⁶ rates of BCS+RT have declined among all older women with ESBC, irrespective of clinical indications.^{12,17,18} The decline in rates may be due to individual patient characteristics. Retrospective studies have shown age and comorbidity to be

TABLE 1. DESCRIPTIVE CHARACTERISTICS OF OLDER WOMEN WITH EARLY-STAGE BREAST CANCER SEER -MEDICARE, 2003–2009

	N	%
<i>All</i>	45924	100.0
Treatment		
BCS+RT	25038	54.5
Mastectomy	10755	23.4
BCS only	10131	22.1
Year of diagnosis		
2003	6620	14.4
2004	6523	14.2
2005	6416	14.0
2006	6493	14.1
2007	6563	14.3
2008	6628	14.4
2009	6681	14.6
Age & health		
Age at diagnosis		
66–69	10319	22.5
70–74	11728	25.5
75–79	10718	23.3
80–84	7974	17.4
85–89	3900	8.5
≥ 90	1285	2.8
Comorbidity score		
0	26024	56.7
1	12422	27.1
≥ 2	7478	16.3
PCP visits		
Low	24805	54.0
High	21119	46.0
Clinical prognostic factors		
Stage at diagnosis		
I	28884	62.9
II	17040	37.1
ER status		
Positive	36321	79.1
Negative	6298	13.7
Borderline/unknown	3305	7.2
PR status		
Positive	30470	66.4
Negative	11754	25.6
Borderline/unknown	3700	8.1
Tumor size		
0–1 cm	14837	32.3
<2 cm	18001	39.2
2–5 cm	12371	26.9
>5 cm	715	1.6
Tumor grade		
Well differentiated	12096	26.3
Moderately differentiated	20024	43.6
Poorly differentiated	10826	23.6
Undifferentiated/unknown	2978	6.5
Oncology care resources		
Mammography screening centers		
Low	23761	51.7
High	22163	48.3
Oncology treatment centers		
Low	25733	56.0
High	20191	44.0
Type of surgeon seen		
General only	8536	18.6

(continued)

TABLE 1. (CONTINUED)

	N	%
<i>All</i>	45924	100.0
Oncology only	2640	5.8
Both	34748	75.7
Socio-demographic characteristics		
Race		
White	41034	89.4
Other	4890	10.7
Education		
<15% college degree	13543	29.5
≥15% college degree	32381	70.5
Annual income		
≤\$35,000	10839	23.6
>\$35,000	35085	76.4
Metro status		
Nonmetro	7673	16.7
Metro	38251	83.3

BCS, breast-conserving surgery; RT, radiation therapy; PCP, primary care physician; ER, estrogen receptor; PR, progesterone receptor; SEER, Surveillance, Epidemiology, and End Results.

the strongest predictors for type of local treatment received. As age and comorbidity increase, so do rates of mastectomy or BCS only.^{9,14,15,18,19} Omission of RT or use of mastectomy, is intended to preserve quality of life and avoid adverse effects in patients with limited life expectancy, frail health, or low functional status. However, RT omission when receiving BCS increases the risk of recurrence, while mastectomy results in loss of breast preservation and greater physical limitations.²⁰

Therefore, the purpose of this study is to determine patterns of local treatment (BCS+RT, mastectomy, or BCS only) among women aged ≥66 years, with stage I and II breast cancer using the U.S. population-based linked SEER-Medicare dataset. Furthermore, this study aims to determine how age, comorbidity, frequency of primary care provider (PCP) visits, clinical prognostic factors, oncology care resources, and socio-demographic characteristics are associated with choice of local treatment.

Materials and Methods

Data source and cohort definition

The SEER-Medicare linked database was created in a collaborative effort by the National Cancer Institute (NCI) and Centers for Medicare and Medicaid Services (CMS). SEER data collected from 17 tumor registries, representing 26% of the United States (US) population, is successfully matched to Medicare enrollment records for 94% of patients aged ≥65 years.²¹ SEER-Medicare data contains information about date of diagnosis, cancer site, stage, tumor characteristics, treatment, healthcare use, patient enrollment and eligibility, selected demographic characteristics, and vital status information. County and state of diagnosis were used to identify the area-level density of mammography screening and oncology centers from the U.S. Department of Health and Human Resource's 2009 Area Resource File (ARF).²² This study was approved for exemption by the West Virginia University Institutional Review Board.

TABLE 2. UNIVARIATE ANALYSIS OF LOCAL TREATMENT AMONG OLDER WOMEN WITH EARLY-STAGE BREAST CANCER SEER-MEDICARE, 2003–2009

	<i>BCS+RT</i>		<i>Mastectomy</i>		<i>BCS Only</i>		<i>p-value</i>
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	
<i>All</i>	25067	54.5	10768	23.4	10146	22.1	
Year of diagnosis							<0.001***
2003	3498	52.8	1646	24.9	1476	22.3	
2004	3502	53.7	1436	22.0	1585	24.3	
2005	3388	52.8	1462	22.8	1566	24.4	
2006	3572	55.0	1418	21.8	1503	23.2	
2007	3636	55.4	1560	23.8	1367	20.8	
2008	3675	55.5	1610	24.3	1343	20.3	
2009	3767	56.4	1623	24.3	1291	19.3	
Age & health							
Age at diagnosis							<0.001***
66–69	6708	65.0	2064	20.0	1547	15.0	
70–74	7259	61.9	2521	21.5	1948	16.6	
75–79	6025	56.2	2523	23.5	2170	20.3	
80–84	3713	46.6	2085	26.2	2176	27.3	
85–89	1151	29.5	1165	29.9	1584	40.6	
≥90	182	14.2	397	30.9	706	54.9	
Comorbidity score							<0.001***
0	14969	57.5	5882	22.6	5173	19.9	
1	6495	52.3	2956	23.8	2971	23.9	
≥2	3574	47.8	1917	25.6	1987	26.6	
PCP visits							<0.001***
Low	14142	57.0	5679	22.9	4984	20.1	
High	10896	51.6	5076	24.0	5147	24.4	
Clinical prognostic factors							
Stage at diagnosis							<0.001***
I	17734	61.4	4508	15.6	6642	23.0	
II	7304	42.9	6247	36.7	3489	20.5	
ER status							<0.001***
Positive	20577	56.7	7855	21.6	7889	21.7	
Negative	3157	50.1	1911	30.3	1230	19.5	
Borderline/Unknown	1304	39.5	989	29.9	1012	30.6	
PR status							<0.001***
Positive	17386	57.1	6453	21.2	6631	21.8	
Negative	6144	52.3	3217	27.4	2393	20.4	
Borderline/unknown	1508	40.8	1085	29.3	1107	29.9	
Tumor size							<0.001***
0–1 cm	9495	64.0	1859	12.5	3483	23.5	
<2 cm	10509	58.4	3622	20.1	3870	21.5	
2–5 cm	4824	39.0	4913	39.7	2634	21.3	
>5 cm	210	29.8	361	50.5	144	20.1	
Tumor grade ^a							<0.001***
Well differentiated	7115	58.8	2194	18.1	2787	23.1	
Moderately differentiated	11119	55.5	4600	23.0	4305	21.5	
Poorly differentiated	5410	50.0	3266	30.2	2150	19.9	
Undifferentiated/unknown	1394	46.8	695	23.4	889	29.9	
Oncology care resources							
Mammography screening centers ^a							<0.001***
Low	12263	51.6	6014	25.3	5484	23.1	
High	12775	57.6	4741	21.4	4647	21.0	
Oncology treatment centers ^a							<0.001***
Low	13378	52.0	6488	25.2	5867	22.8	
High	11660	57.8	4267	21.1	4264	21.1	
Type of surgeon seen ^a							<0.001***
General only	3627	42.5	2027	23.8	2882	33.8	
Oncology only	1535	58.1	605	22.9	500	18.9	
Both	19876	57.2	8123	23.4	6749	19.4	

(continued)

TABLE 2. (CONTINUED)

	<i>BCS+RT</i>		<i>Mastectomy</i>		<i>BCS Only</i>		<i>p-value</i>
	N	%	N	%	N	%	
<i>All</i>	25067	54.5	10768	23.4	10146	22.1	
Socio-demographic characteristics							
Race ^a							<0.001***
White	22667	55.2	9377	22.9	8990	21.9	
Other	2371	48.5	1378	28.2	1141	23.3	
Education ^a							<0.001***
<15% college degree	6311	46.6	3869	28.6	3363	24.8	
≥15% college degree	18727	57.8	6886	21.3	6768	20.9	
Annual income ^a							<0.001***
≤\$35,000	4872	45.0	3137	28.9	2830	26.1	
>\$35,000	20166	57.5	7618	21.7	7301	20.8	
Metro status ^a							<0.001***
Nonmetro	3360	43.8	2287	29.8	2026	26.4	
Metro	21678	56.7	8468	22.1	8105	21.2	

p* < 0.05.*p* < 0.01.****p* < 0.001.

We identified 69,376 females aged ≥66 years with a first ever and primary diagnosis of stage I or II incident case of breast cancer between January 1, 2003 and December 31, 2009 who were continuously enrolled in Medicare Part A and B fee-for-service programs 1 year before and after diagnosis. Other exclusion criteria were as follows: enrollment in managed care programs at any time during the year before or after diagnosis (*n* = 20,872), died within the first year of diagnosis (*n* = 710), if tumor size was missing (*n* = 64), if surgeon specialty was missing (*n* = 852), or did not have any definitive surgery (*n* = 954). After these exclusions, the final analytic sample consisted of 45,924 patients.

Local treatment variable

The local treatment received (BCS+RT, mastectomy, or BCS only) was identified using surgical and Medicare radiation claims where the claim date was within 366 days of the diagnosis. BCS (*i.e.*, lumpectomy, partial mastectomy, segmental mastectomy), mastectomy, and RT were identified using *International Classification of Diseases, 9th Revision* (ICD-9) diagnosis and procedure codes and Current Procedural Terminology/Healthcare Common Procedure Coding System (CPT/HCPCS) (Appendix 1).

Explanatory variables

Explanatory variables used in this study include individual-level and area-level measures. Individual-level patient characteristics included diagnosis year, age, race, comorbidity, frequency of PCP visits, clinical prognostic factors, and surgeon specialty. Area-level measures include census tract level of education, census tract level of income, metro status, local density of mammography screening facilities, and local density of oncology treatment centers. Comorbidity scores were calculated using the Klabunde adaptation of the Charlson index (score = 0, 1, ≥ 2).^{23,24} Frequency of PCP visits was determined by counting the number of unique PCP claim dates the year before diagnosis and dividing by lower and upper 50th percent median cutoff. Clinical prognostic factors included

stage at diagnosis, ER status, progesterone receptor (PR) status, and tumor grade. Oncology care resources were captured by the area-level density of mammography screening and oncology treatment centers, and specialty of the treating surgeon. Area-level densities were determined by dividing proportions found in the ARF by lower and upper 50th percent median cutoffs. Surgeon specialty (general only, oncology only, or both) was ascertained using provider specialty claims codes. Demographic characteristics were race, metro status, census-tract level, education, and income

Statistical analysis

Patient characteristics were summarized using descriptive statistics. Mantel-Haenszel chi-square tests of location shift, using either modified ridit scores or table scores, and Mantel-Haenszel chi-square tests of general association, depending on whether the independent measure was dichotomous, nominal, or ordinal, were used to compare significant group differences between patients receiving BCS+RT, mastectomy, or BCS only. Two multivariable logistic regression models were used to estimate likelihood for type of local treatment received (mastectomy vs. BCS+RT and BCS only vs. BCS+RT), adjusting for year of diagnosis, age and health characteristics, clinical prognostic factors, oncology care resources, and socio-demographic characteristics. Parameter estimates calculated in the regression models are presented as adjusted odds ratios (AOR) with their corresponding 95% confidence intervals (CI). *p* values <0.05 were considered statistically significant. Analysis was conducted using SAS version 9.4 software (SAS Institute, Inc., Cary, NC).

Results

Patient characteristics

Of 45,924 female fee-for-service Medicare beneficiaries diagnosed in 2003–2009 and in our analytic sample 54.5% received BCS+RT, 23.4% had mastectomy, and 22.1% had BCS only; 25.5% were aged 70–74 years at diagnosis, and

TABLE 3. ODDS RATIOS FROM THE FULLY ADJUSTED MODEL OF LOCAL TREATMENT
AMONG OLDER WOMEN WITH EARLY-STAGE BREAST CANCER SEER-MEDICARE, 2003–2009

	<i>Treatment</i>					
	<i>Mastectomy vs. BCS+RT</i>			<i>BCS Only vs. BCS+RT</i>		
	<i>AOR</i>	<i>95% CI</i>	<i>Sig.</i>	<i>AOR</i>	<i>95% CI</i>	<i>Sig.</i>
Year of diagnosis						
2003	1.00	—		1.00	—	
2004	0.95	0.87–1.04		1.15	1.05–1.26	**
2005	1.01	0.92–1.10		1.22	1.11–1.33	***
2006	0.95	0.87–1.04		1.13	1.03–1.23	*
2007	1.03	0.95–1.13		0.99	0.91–1.09	
2008	1.08	0.99–1.18		1.00	0.91–1.09	
2009	1.08	0.98–1.17		0.94	0.85–1.03	
Age & health						
Age at diagnosis						
66–69	1.00	—		1.00	—	
70–74	1.12	1.05–1.20	**	1.12	1.04–1.21	**
75–79	1.40	1.30–1.50	***	1.49	1.38–1.61	***
80–84	1.87	1.73–2.02	***	2.39	2.21–2.59	***
85–89	3.21	2.90–3.55	***	5.39	4.89–5.94	***
≥90	6.16	5.10–7.44	***	14.13	11.80–16.80	***
Comorbidity score						
0	1.00	—		1.00	—	
1	1.08	1.02–1.14	*	1.22	1.16–1.30	***
≥2	1.14	1.07–1.22	***	1.38	1.29–1.48	***
PCP visits						
Low	1.00	—		1.00	—	
High	1.05	1.00–1.10	*	1.10	1.05–1.16	***
Clinical prognostic factors						
Stage at diagnosis						
I	1.00	—		1.00	—	
II	3.15	3.00–3.31	***	1.26	1.19–1.32	***
ER status						
Positive	1.00	—		1.00	—	
Negative	1.19	1.09–1.30	***	1.03	0.93–1.13	
Borderline/unknown	1.56	1.24–1.96	***	1.47	1.16–1.84	***
PR status						
Positive	1.00	—		1.00	—	
Negative	1.12	1.05–1.20	***	0.99	0.92–1.07	
Borderline/unknown	1.18	0.95–1.47		1.17	0.94–1.46	
Tumor size						
0–1 cm	1.00	—		1.00	—	
<2 cm	1.58	1.48–1.69	***	0.96	0.91–1.02	
2–5 cm	2.92	2.65–3.22	***	1.30	1.17–1.44	***
>5 cm	4.73	3.88–5.75	***	1.47	1.15–1.87	**
Tumor grade						
Well differentiated	1.00	—		1.00	—	
Moderately differentiated	1.06	0.99–1.12		0.95	0.89–1.01	
Poorly differentiated	1.12	1.04–1.21	**	0.93	0.86–1.00	*
Undifferentiated/unknown	1.15	1.03–1.28	*	1.40	1.27–1.55	***
Oncology care resources						
Mammography screening centers						
Low	1.00	—		1.00	—	
High	0.99	0.90–1.09		0.89	0.80–0.98	*
Oncology treatment centers						
Low	1.00	—		1.00	—	
High	0.85	0.77–0.93	***	1.04	0.94–1.14	
Type of surgeon seen						
General only	1.00	—		1.00	—	
Oncology only	0.78	0.70–0.88	***	0.56	0.50–0.63	***
Both	0.79	0.74–0.84	***	0.57	0.53–0.60	***

(continued)

TABLE 3. (CONTINUED)

	<i>Treatment</i>					
	<i>Mastectomy vs. BCS+RT</i>			<i>BCS Only vs. BCS+RT</i>		
	<i>AOR</i>	<i>95% CI</i>	<i>Sig.</i>	<i>AOR</i>	<i>95% CI</i>	<i>Sig.</i>
Socio-demographic characteristics						
Race						
White	1.00	—		1.00	—	
Other	1.29	1.20–1.40	***	1.25	1.15–1.36	***
Education						
<15% college degree	1.00	—		1.00	—	
≥15% college degree	0.75	0.70–0.79	***	0.81	0.76–0.86	***
Annual income						
≤\$35,000	1.00	—		1.00	—	
>\$35,000	0.88	0.82–0.94	***	0.84	0.78–0.90	***
Metro status						
Nonmetro	1.00	—		1.00	—	
Metro	0.70	0.65–0.76	***	0.73	0.67–0.78	***

* $p < 0.05$.** $p < 0.01$.*** $p < 0.001$.

AOR, adjusted odds ratios; CI, confidence interval.

56.7% had comorbidity score = 0. Most were treated by both general and oncology surgeons (75.7%) (Table 1).

Univariate analysis

All p -values are significant at the $p < 0.001$ level. The proportion of patients receiving BCS+RT decreased with increasing age: 65.0% of women 66–69 years to 14.2% of women ≥90 years (Table 2). In contrast, rates of mastectomy and BCS only were highest among those aged ≥90 years versus 66–69 years (30.9% and 54.9% vs. 20.0% and 15.0%). Women with a comorbidity score = 2 versus 0 had the lowest rates of BCS+RT (47.8% vs. 57.5%), while rates of mastectomy (25.6% vs. 22.6%) and BCS only (26.6% vs. 19.9%) were the highest among women with a score = 2 versus 0. Patients with stage I disease, hormone receptor-positive, and well-differentiated tumors had higher rates of BCS+RT, while those with poor prognostic factors had higher rates of mastectomy and BCS only. Women treated by an oncology surgeon only or both an oncology and general surgeon had the highest rates of BCS+RT, compared to those treated by a general surgeon only, while rates of BCS only were the highest among those treated by a general surgeon only.

Multivariate analysis

The two models of factors associated with treatment (Mastectomy vs. BCS+RT and BCS only vs. BCS+RT) of ESBC among elderly women is given in Table 3. Compared to women aged 66–69 years, women of increasing age were more likely to be treated with mastectomy and BCS only versus BCS+RT, with women aged ≥90 years being the most likely to have mastectomy (AOR 6.16, 95% CI, 5.10–7.44) and BCS only (AOR 14.13, 95% CI, 11.80–16.80). Greater comorbidity (score = 2) was associated with an increased likelihood of have mastectomy (AOR 1.14, 95% CI, 1.07–1.22) and BCS only (AOR 1.38, 95% CI, 1.29–1.48). Women diagnosed with stage II breast cancer were more likely to

receive mastectomy (AOR 3.15, 95% CI, 3.00–3.31) and BCS only (AOR 1.26, 95% CI, 1.19–1.32) versus BCS+RT. Those with negative and borderline/unknown ER and PR tumors, and moderately, poorly, and undifferentiated/unknown tumors were more likely to have mastectomy or BCS only.

Women, residing in areas with a high-density of mammography screening centers were less likely to be treated with BCS only versus BCS+RT (AOR 0.89, 95% CI, 0.80–0.98). Similarly, women residing in areas with a high-density of oncology treatment centers (AOR 0.85, 95% CI, 0.77–0.93) were less likely to have mastectomy. Compared to women treated by a general surgeon only, those treated by an oncology surgeon only or treated by both types of surgeons were less likely (AOR 0.78, 95% CI, 0.70–0.88 and AOR 0.79, 95% CI, 0.74–0.84) to receive mastectomy, or BCS only (AOR 0.56, 95% CI, 0.50–0.63 and AOR 0.57, 95% CI, 0.53–0.60). Women of other races were more likely to have mastectomy or BCS only. Women living in areas of greater education, income, or metro status were less likely to receive mastectomy or BCS only.

Stratified analysis

Taking into account the guideline recommendation that BCS only may be an appropriate option for some women aged ≥70 years, we performed a stratified analysis on women aged 66–69 with comorbidity = 0 who would have been recommended to receive BCS+RT, thus eliminating patients who were eligible for BCS only as a treatment option (Table 4). Therefore, a secondary analysis was conducted to explore associations with treatment among these (age 66–69 years at diagnosis and a Charlson comorbidity score = 0) (Table 4). Among this subgroup of women ($n = 6,369$), 66.7% were treated with BCS+RT, 19.5% mastectomy, and 13.9% BCS only. Women diagnosed at stage II were more likely (AOR 1.91, 95% CI 1.55–2.35) to be treated with mastectomy, than those diagnosed at stage I. Women with ER negative tumors

TABLE 4. CHARACTERISTICS AND ADJUSTED ODDS RATIOS OF WOMEN AGED 66–69 YEARS
AND WITH A CHARLSON COMORBIDITY SCORE=0 DIAGNOSED WITH EARLY-STAGE BREAST CANCER
IN SEER REGIONS SEER -MEDICARE, 2003–2009

	<i>Treatment</i>							
			<i>Mastectomy vs. BCS + RT</i>			<i>BCS Only vs. BCS + RT</i>		
	N	%	AOR	95% CI	Sig.	AOR	95% CI	Sig.
<i>All</i>	6369	100.0						
Treatment								
BCS+Radiation	4246	66.7						
Mastectomy	1239	19.5						
BCS only	884	13.9						
Year of diagnosis								
2003	875	13.7	1.00	—		1.00	—	
2004	908	14.3	0.90	0.70–1.17		1.11	0.85–1.45	
2005	896	14.1	0.90	0.70–1.16		1.07	0.82–1.41	
2006	888	13.9	0.83	0.64–1.08		1.06	0.81–1.40	
2007	932	14.6	0.89	0.70–1.15		0.89	0.67–1.17	
2008	961	15.1	1.27	1.00–1.62		1.02	0.77–1.35	
2009	909	14.3	1.12	0.87–1.44		0.80	0.60–1.08	
Age & health								
PCP visits								
Low	4622	72.6	1.00	—		1.00	—	
High	1747	27.4	0.95	0.81–1.10		1.05	0.89–1.24	
Clinical prognostic factors								
Stage at diagnosis								
I	4142	65.0	1.00	—		1.00	—	
II	2227	35.0	1.91	1.55–2.35	***	1.17	0.91–1.50	
ER status								
Positive	5055	79.4	1.00	—		1.00	—	
Negative	933	14.7	1.25	0.98–1.60		1.07	0.80–1.42	
Borderline/unknown	381	6.0	1.90	0.91–3.96		1.07	0.56–2.07	
PR status								
Positive	4261	66.9	1.00	—		1.00	—	
Negative	1682	26.4	1.19	0.98–1.45		0.97	0.77–1.22	
Borderline/unknown	426	6.7	0.91	0.44–1.86		1.73	0.93–3.24	
Tumor size								
0–1 cm	2220	34.9	1.00	—		1.00	—	
>2 cm	2570	40.4	1.62	1.36–1.94	***	0.93	0.78–1.12	
2–5 cm	1498	23.5	2.86	2.21–3.70	***	1.56	1.15–2.10	**
>5 cm	81	1.3	4.31	2.52–7.35	***	1.60	0.78–3.29	
Tumor grade								
Well differentiated	1694	26.6	1.00	—		1.00	—	
Moderately differentiated	2788	43.8	1.09	0.91–1.30		1.00	0.83–1.21	
Poorly differentiated	1494	23.5	1.10	0.89–1.36		1.27	1.01–1.60	*
Undifferentiated/unknown	393	6.2	1.37	1.01–1.85	*	1.61	1.18–2.18	**
Oncology care resources								
Mammography screening centers								
Low	3386	53.2	1.00	—		1.00	—	
High	2983	46.8	1.20	0.93–1.55		0.86	0.63–1.17	
Oncology treatment centers								
Low	3656	57.4	1.00	—		1.00	—	
High	2713	42.6	0.81	0.63–1.05		1.13	0.84–1.54	
Type of surgeon seen								
General only	761	12.0	1.00	—		1.00	—	
Oncology only	393	6.2	0.96	0.69–1.35		0.44	0.29–0.66	***
Both	5215	81.9	0.92	0.74–1.14		0.65	0.53–0.80	***
Socio-demographic characteristics								
Race								
White	5786	90.9	1.00	—		1.00	—	
Other	583	9.2	1.22	0.98–1.53		1.30	1.02–1.67	*
Education								
<15% college degree	1699	26.7	1.00	—		1.00	—	
≥15% college degree	4670	73.3	0.85	0.71–1.01		0.90	0.74–1.09	
Annual income								
≤\$35,000	1295	20.3	1.00	—		1.00	—	
>\$35,000	5074	79.7	0.78	0.65–0.95	*	0.65	0.53–0.80	***
Metro status								
Nonmetro	1115	17.5	1.00	—		1.00	—	
Metro	5254	82.5	0.79	0.64–0.96	*	0.79	0.63–0.98	*

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

were more likely to be treated with mastectomy, than those with ER positive tumors. Women with undifferentiated/unknown and poorly differentiated tumors were also more likely to be treated with mastectomy or BCS only versus BCS+RT. Compared to those treated by a general surgeon only, women treated by an oncology surgeon (AOR 0.44, 95% CI, 0.29–0.66) or both an oncology and general surgeon (AOR 0.65, 95% CI, 0.53–0.80) were less likely to be treated with BCS only versus BCS+RT.

Discussion

This is the most recent population-based study to examine patterns of local treatment of ESBC among older women. Previous retrospective studies show that older women are more likely to be treated with mastectomy or BCS only, than BCS+RT. We demonstrated that from 2003 to 2009, 22% had BCS without RT, similar to published studies.²⁵ However, the rates of BCS with RT are lower and mastectomy are higher as compared to published literature. Although these differences may in part be due to differences in study inclusion/exclusion criteria, recent studies examining trends in treatment for ESBC have found that women are increasingly opting for more aggressive treatment, such as mastectomy.^{26,27}

Consistent with previous studies,^{10,28} age was strongly associated with BCS only or mastectomy. Increasing age is commonly cited as the main reason for omission of RT among older women due to greater comorbidity, intolerance to RT toxicity, adverse effects, and shorter life expectancy.^{14,29,30} In fact, RT is not always recommended for all women over the age of 70 years, as it has not been shown to improve survival among those with shortened life expectancies.³¹ Similarly, older women may be more likely to receive mastectomy to avoid any adverse effects associated with RT following BCS. However, not all experts agree that RT is more toxic or less tolerable among older women, than younger women. In fact, several studies have found RT to be well-tolerated among older women, and determined that it did not increase the risk of myocardial infarction or cardiovascular disease.^{32,33} Declining health is a common occurrence among older individuals, and presents additional challenges to undergoing cancer treatments, particularly RT. Although patients with a comorbidity score = 2 were more likely to have mastectomy or BCS only, 43% of women with a score = 0 were treated with mastectomy or BCS only, suggesting that increased comorbidity may not always drive the type of treatment.

Women diagnosed at stage II versus I, were over three times more likely to undergo mastectomy. While the likelihood of mastectomy intuitively increases with increasing stage, it may be that the increasing use of mastectomy among older women can also be partially explained by age. Mastectomy may be increasingly utilized to avoid any adverse effects of RT and the burden of multiple treatments. However, women who had an oncology surgeon involved in their treatment were less likely to be treated with mastectomy or BCS only. Evidence suggest that surgeon specialty is associated with more advanced methods of breast cancer treatment,³⁴ and having both an oncology and general surgeon involved may be an indication of caseload sharing within high volume treatment centers, a factor associated with better

treatment practices.³⁵ Moreover, those treated by an oncology surgeon may have shorter travel distances to access specialty care or are more likely to undergo treatments that require repeated visits, such as BCS+RT.³⁶ This may explain why patients who resided in areas with a high density of mammography screening and oncology treatment centers were less likely to have BCS only or mastectomy.

Findings from the stratified analysis of women who were the youngest and healthiest at diagnosis, and thus the most ideal candidates for BCS+RT, barring other unknown factors, showed that considerably more of these women were treated with BCS+RT, than the entire study sample (66.6% vs. 54.5%). It is understandable from a clinical perspective that those diagnosed at stage II versus I and with unfavorable tumor characteristics were more likely to be treated with mastectomy. However, it is troubling that some groups of women in this stratified analysis were also more likely to be treated with BCS only. Not only do women in this subgroup not meet the NCCN guideline requirements for omission of RT because of age, but patients with these cancer characteristics often require more aggressive treatments that include RT when BCS is the surgical treatment choice. It is possible that this finding is explained by the socio-demographic disparities in treatment observed in this subgroup analysis. Women of other race were more likely to be treated with BCS only, while those residing in areas of higher income, and metro areas were less likely to be treated with BCS only. Similarly, women residing in areas of higher education, higher income, and metro areas were less likely to be treated with mastectomy. Therefore, women with vulnerable socio-demographic characteristics with difficulty accessing equitable treatment may also have not been receiving routine mammography screening before diagnosis, leading to a later stage at diagnosis. In the multivariate analyses of the whole study sample, women who had were treated by an oncology surgeon only or both an oncology and general surgeon were less likely to receive mastectomy or BCS only. In the subgroup analysis only a difference in the likelihood for treatment with BCS only was observed. Younger, healthier patients who had an oncology surgeon as part of their care were 35%–56% less likely to have BCS only. This finding reiterates the importance of having an oncology specialist as member of the patient's oncology care team to ensure that all patients have access to specialized oncology care.

Several limitations should be noted when interpreting the results of this study. While this study examined the relationships between type of treatment and a range of covariates, patient preference was not measured. Completion of RT was not assessed, only the initiation of therapy. Another limitation is the lack of information available regarding patients' HER2/neu tumor status and its association with type of treatment. Given that women diagnosed at stage I and II have 99% and 93% 5-year overall survival rates,³⁷ respectively, it is likely that those who die within the first year of diagnosis, die from noncancer related causes. Because this study excluded women who died in the first year following diagnosis, the findings may underrepresent the proportion of women who received less aggressive treatment due to poor health or old age. Finally, the SEER individuals within the SEER database have been found to be of higher income, and higher concentrations of racial and ethnic minorities, compared to the U.S. population.³⁸

Conclusions

A little more than half of older women receive BCS+RT for treatment of ESBC. Women of increasing age, comorbidity, and stage were the most likely to have mastectomy or BCS only. While it may not be appropriate for all elderly women with ESBC to receive RT, some groups of women still do not receive RT with BCS when they are clinically indicated to do so. In particular, this study identified a subgroup of women younger than 70 years, whose omission of RT was associated with access to an oncology specialist and socioeconomic disparities. Current research focusing on individualized and targeted therapies, and immunotherapy may provide more tolerable treatment options for the elderly population. Furthermore, continued efforts are needed to ensure all patients have equitable access to oncology specialty resources and treatment options.

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Author Disclosure Statement

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APPENDIX 1. CLAIMS CODES USED FOR IDENTIFYING TYPES OF TREATMENT

<i>Type of Treatment</i>	<i>ICD-9 Diagnostic</i>	<i>ICD-9 Procedure</i>	<i>HCPSCS/CPT</i>	<i>Revenue Center</i>
Breast-Conserving Surgery		85.20–85.29	19120, 19125–19126, 19160, 19162, 19301–19302	
Mastectomy		85.33–85.36, 85.40–85.48	19140, 19180, 19182, 19300, 19303–19307, 19200, 19220, 19240, 19260, 19271–19272	
Radiation Therapy	V58.0, V66.1, V67.1	92.20–92.39	77261–77799, G0256, G0261, G0173–G0174, G0243, G0251, G0338–G03340	0030, 0033