Published in final edited form as:
Ann Surg. 2011 August ; 254(2): 339–345. doi:10.1097/SLA.0b013e3182263bb0.

Institutional Variation in the Surgical Treatment of Breast Cancer:

A Study of the NCCN

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Abstract

Objective—To investigate the relationship between supply of subspecialty care and type of procedure preferentially performed for early stage breast cancer.

Background—Three surgical options exist for early stage breast cancer: (1) breast conserving surgery (BCS), (2) mastectomy with reconstruction (RECON), and (3) mastectomy alone. Current guidelines recommend that surgical treatment decisions should be based on patient preference if a patient is eligible for all 3. However, studies demonstrate persistent variation in the use of BCS and RECON.

Methods—Patients undergoing an operation for DCIS or stage I or II breast cancer at NCCN institutions between 2000 and 2006 were identified. Institutional procedure rates were determined. Spearman correlations measured the association between procedure types. Patient-level logistic regression models investigated predictors of procedure type and association with institutional supply of subspecialty care.

Results—Among 10,607 patients, 19% had mastectomy alone, 60% BCS, and 21% RECON. The institutional rate of BCS and RECON were strongly correlated ($r = -0.80$, $P = 0.02$). Institution was more important than all patient factors except age in predicting receipt of RECON

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or BCS. RECON was more likely for patients treated at an institution with a greater supply of reconstructive surgeons or where patients live further from radiation facilities. RECON was less likely at institutions with longer waiting times for surgery with reconstruction.

Conclusions—Even within the NCCN, a consortium of multidisciplinary cancer centers, the use of BCS and mastectomy with reconstruction substantially varies by institution and correlates with the supply of subspecialty care.

There are 3 options for the surgical treatment of early stage breast cancer: (1) breast conserving surgery (BCS), (2) mastectomy with reconstruction, and (3) mastectomy alone. Each procedure offers appropriate treatment, but carries differing risks including increased recovery time, which may delay systemic treatment for reconstruction and increased risk of local recurrence for BCS.[1–4] If a patient is a candidate for all 3 approaches, guidelines recommend that the decision be based on patient preference.[5,6] Studies using patient self-report suggest this recommendation is being followed. In one population-based study, 75% of patients reported that they either made the decision or participated in the decision-making regarding the surgical management of their breast cancer.[7] Despite this, there is regional and institutional variation in the utilization of BCS and postmastectomy reconstruction that is not explained by patient preference.[8,9]

One possible explanation for this variation is that the supply and quality of subspecialty care, particularly adjuvant radiation and reconstructive surgery, could bias provider presentation in favor of one procedure or another and therefore drive practice patterns. To explore this, we sought to evaluate institutional variation in surgical therapy for early stage breast cancer within the National Comprehensive Cancer Network (NCCN). We hypothesized that there would be a strong inverse correlation between the institutional rate of BCS and mastectomy with reconstruction, but that the institutional rate of mastectomy alone would not correlate with the rate of either of the other procedures. Furthermore, we postulated that the supply of subspecialty care, particularly reconstructive surgery and adjuvant radiation, at the institutional level would correlate with whether BCS or mastectomy with reconstruction was preferentially performed.

Methods

Subjects

The cohort consisted of women with newly diagnosed ductal carcinoma in situ (DCIS) or stage I or II invasive breast cancer who underwent an operation at 1 of the 8 institutions participating in the NCCN Breast Cancer Outcomes Project between January 1, 2000 and December 31, 2006. The institutions are: City of Hope Comprehensive Cancer Center, Duarte, CA; Dana- Farber Cancer Institute, Boston, MA; Fox Chase Cancer Center, Philadelphia, PA; H. Lee Moffitt Cancer Center and Research Institute, Tampa FL; The Ohio State University Comprehensive Cancer Center, Columbus, OH; Roswell Park Cancer Institute, Buffalo, NY; The University of Texas MD Anderson Cancer Center, Houston, TX; and University of Michigan Comprehensive Cancer Center, Ann Arbor, MI. Each center is an academic comprehensive cancer center where most physicians treating breast cancer devote most or all of their clinical effort to breast cancer care. The Institutional Review Board (IRB) at each center has approved the study, data collection process, data transmission methods, and data storage protocols. This analysis was approved by the IRB at the Dana-Farber/Harvard Cancer Center, Boston, MA.

Each patient had at least 365 days of follow-up after her first NCCN visit. If a woman had multiple breast cancer episodes, only the first episode was included. We excluded patients who did not receive cancer-directed surgery or received their definitive surgery at an institution outside the NCCN. We identified 11,123 eligible women undergoing definitive surgery at an NCCN institution. Our final cohort included 10,607 patients after 516 patients were excluded because their final pathology revealed more advanced disease.

Data Sources

Data collected from the patients' medical records for the NCCN Outcomes Project include sociodemographics, type of health insurance at presentation, AJCC stage, tumor pathology, all treatments administered and recurrences.[10–15] Comorbidity at presentation is assigned using either the Charlson Index or the modified version of that index using a patient survey developed by Katz et al.[16,17] Employment status at diagnosis and educational status at presentation are collected via patient survey. Income was estimated using the median household income from the 2000 Census data for the patient's residence. Height and weight at presentation are obtained from medical records and used to calculate body mass index. Distance to nearest radiation facility is calculated for each patient using their zip code upon presentation and the American Hospital Association Hospital Statistics from 2000.

Rigorous data quality assurance processes are in place, including data management training; on-line edit checking during web-based data entry; programmed logic checks against the pooled data repository; routine quality assurance reports to the centers for rectification by the data managers; and on-site audits of a random sample of source documents against the submitted data within the first few months of data collection, and annually thereafter.

An electronic survey was sent to each NCCN site principal investigator to determine the number of reconstructive surgeons and the number of radiation oncologists on staff and treating breast cancer at the beginning of the study period.

Definition of Type of Definitive Surgery Received

Patients were categorized into definitive surgery groupings based on the data collected regarding surgical procedures. If patients had multiple documented surgeries (eg, BCS and subsequent mastectomy), a second review of the patient's medical record determined the first attempt at definitive treatment. For patients who received mastectomy as their definitive surgery, the receipt of breast reconstruction was defined as an ipsilateral breast reconstruction surgery code with a procedure date on the same day or within 365 days of the procedure code for mastectomy and before the date of any recurrence.

Data Analysis

The proportion of women undergoing each type of surgery in the overall cohort and at each institution was calculated. We investigated bivariate correlations for the different procedures at the institutional level using Spearman correlation coefficients. Because of the small sample size at the institution level as well as the constraint that the proportions must sum to 1 within an institution, we used an exact permutation P value for significance testing.

To evaluate patient-level determinants, we performed bivariate analyses by calculating the proportion of patients receiving each type of surgery according to a priori potential explanatory variables related to clinical and treatment factors as well as socioeconomic status. To investigate time trends, we also looked at year of diagnosis. Significance testing was performed using χ^2 analysis.

We then constructed multivariable patient-level logistic regression models to compare patients who received mastectomy with reconstruction to those who received BCS. We included variables for tumor size and number of positive lymph nodes rather than overall stage in these models. All other statistically significant clinical and socioeconomic factors on bivariate analysis were considered for inclusion. The percentage of missing data on each variable is provided in Table 1. A separate category was analyzed for variables where more than 5% of the data was missing or unknown. For the remaining variables, these data were excluded from analysis. Patients with missing data were found to be similar to patients without missing data in terms of baseline characteristics, including the outcome, and thus the estimates of the multivariate model should be unbiased when limited to patients without missing data. To confirm this, we performed additional analyses including a customized multiple imputation technique for multiple categorical variables, with 30 multiple imputations. The results were similar to the results limited to patients without missing data, so we present the results in which patients with missing data are excluded from the model.

The first model included institution as a fixed effect. The results are presented as odds ratios with 95% confidence intervals and *P* values. The baseline c-statistic and logistic regression pseudo-R^2 for the model was calculated. To determine the comparative effect of institution and each patient level variable, the change in logistic regression pseudo-R^2 was determined.

Logistic regression models were then built to determine the impact of subspecialty care. There was no institutional variable included, but instead institutional measures of supply of subspecialty care as a fixed effect. These included the number of reconstructive surgeons and radiation oncologists on staff per 100 annual breast procedures, the difference in mean time from diagnosis to operation among patients who underwent reconstruction compared to those having breast procedures without reconstruction, and an institutional level variable for the mean distance from the patient's residence to the nearest radiation facility for each institution. For each institutional measure, we present the odds of receiving mastectomy with reconstruction (as compared to BCS) after adjusting for significant patient-level characteristics.

All *P* values were 2-sided, and were considered statistically significant if $P < 0.05$. All analyses were performed with SAS version 9.1.3 (SAS Institute, Cary, NC).

Results

Table 1 describes the characteristics of the 10,607 patients included in the cohort. Nineteen percent of patients had mastectomy alone, 60% had BCS, and 21% had mastectomy with reconstruction. Table 2 lists the bivariate associations between patient characteristics and each type of surgical procedure.

Figure 1 illustrates the institutional variation in utilization rates for the 3 procedures. There was a strong inverse correlation between the institutional rates of BCS and mastectomy with reconstruction ($r = -0.80$, $P = 0.02$). In contrast, there was no correlation between the institutional rate of mastectomy alone and BCS ($r = -0.14$, $P = 0.74$) or mastectomy alone and mastectomy with reconstruction ($r = -0.19$, $P = 0.65$).

Multivariable Analysis with Institution as Fixed Effect

After excluding patients who received mastectomy alone (N = 1976) and patients with missing data (N = 1151) the final multivariable model predicting receipt of mastectomy with reconstruction compared to BCS was based on 7480 patients and included age, institution, systemic treatment, BMI, tumor size, comorbidity score, income level, number of positive lymph nodes, and HR status as significant predictors of procedure type. This model had a c-statistic of 0.769 and a pseudo-R^2 of 0.249. Institution (%ΔR^2 = 14%) was more important than all patient factors except age (%ΔR^2 = 26%) in predicting whether a patient received mastectomy with reconstruction (Table 3).

Analysis of Institutional Resources

We then replaced the fixed hospital effect in the previous model with various hospital measures of subspecialty care. There was a wide range of staffing at the institutions in this analysis. The number of reconstructive surgeons per 100 annual breast procedures ranged from 0.63 to 3.0. Similarly, the number of radiation oncologists per 100 annual breast procedures ranged from 0.29 to 7.2.

After adjusting for significant patient characteristics, including age, systemic treatment, BMI, comorbidity score, income level, tumor size, number of positive nodes, and HR status, patients treated at institutions with more reconstructive surgeons were more likely to undergo mastectomy with reconstruction as compared to BCS (OR 1.38 [per additional reconstructive surgeon per 100 annual breast procedures]; 95%CI, 1.29–1.48; $P < 0.0001$). There was also a lower probability of mastectomy with reconstruction for patients treated at institutions with a longer waiting time from diagnosis to surgery for reconstructive procedures (OR 0.96 [per additional day]; 95% CI, 0.95–0.97; $P < 0.0001$). Patients treated at institutions with longer mean travel distance to the nearest radiation facility were more likely to receive mastectomy with reconstruction (and less likely to receive BCS) (OR 1.03 [per mile], 95% CI, 1.00–1.05; $P = 0.014$). The ratio of radiation oncologists to annual breast procedures (OR 0.98; 95% CI, 0.93–1.02; $P = 0.23$) did not significantly correlate with the type of operation.

Discussion

With the acceptance of BCS as appropriate treatment for early stage breast cancer, many believed that the use of mastectomy should and would decrease.[18,19] However, many patients continue to undergo mastectomy.[20,21] Some have suggested that this persistence of mastectomy as treatment for early stage breast cancer reflects a lack of patient understanding and decision-making.[22] Several recent studies suggest that the opposite is true and mastectomy is associated with higher rates of patient involvement in decision-making.[7,23] One explanation is the increasing use of immediate breast reconstruction, which is now a viable option for most women.[24]

Studies most often compare patients undergoing BCS to those who receive mastectomy without considering reconstruction. This modeling of the decision-making process fails to account for the prominent role of reconstruction in the current management of breast cancer. Patients who undergo mastectomy with reconstruction differ from patients who undergo mastectomy alone, in terms of both patient characteristics and functional and psychosocial outcomes.[25–27] We believe that they more closely resemble patients who receive BCS in that there is a breast mound at the completion of treatment. This led us to a different conceptual model of decision-making; one where the first decision is whether mastectomy alone is appropriate and acceptable and then for the remaining patients whether the breast mound is preserved through BCS or reconstruction. Recent studies that do compare BCS and mastectomy with reconstruction in terms of quality of life and patient satisfaction, including a recent review from the Mayo Clinic fail to provide a consistent pattern and suggest that outcomes are influenced by patient characteristics such as age and socioeconomics, underscoring the importance of individualized decision-making.[27–33]

Many states have laws requiring that surgeons discuss both mastectomy and BCS; however, the content and extentofthese discussions is quite variable.[34] The wide range of surgeon rates for both BCS (27%–85%) and postmastectomy reconstruction (6%–84%) suggests that physician influence may be a powerful determinant of treatment choice, but little is known about the factors that shape how physicians present treatment options.[35] A recent study found that the majority of between-surgeon variation for reconstruction was explained by a single variable "surgeon's share of new patients in their practice for whom the surgeon talked to a plastic surgeon before surgery".[36] This ability to talk to a plastic surgeon will be influenced by the supply and quality of plastic surgeons available to the breast surgeon.

Access to subspecialty care has also been shown to influence choice of primary breast cancer treatment at the patient level. Consultation with a radiation oncologist and proximity to a radiation facility has been associated with increased use of BCS. [37,38] Another study has linked low referral for reconstruction to perceived barriers in access.[39] Access to subspecialty care is an institutional resource and could influence which procedure is preferentially performed at an institutional level.

In this study, we found a strong inverse correlation between institutional rates of BCS and mastectomy with reconstruction, but no correlation between rates of mastectomy alone and the other procedure types. In other words, the probability that a woman will end up with her native breast or a reconstructed breast depends to a substantial degree on where she chooses to receive her care.

This institutional variation correlated with the supply of subspecialty care. After controlling for patient characteristics, we found that patients were 38% more likely to undergo mastectomy with reconstruction as compared to BCS for each additional reconstructive surgeon on staff per 100 breast surgeries performed at an institution. We also found a 4% decrease in the likelihood of mastectomy with reconstruction for each additional day of wait time for reconstructive procedures.

There are several possible explanations for this association between the institutional supply of reconstruction and practice patterns in the surgical care of early stage breast cancer. Certain institutions may develop a reputation for excellence in one type of procedure and patients who desire that approach may preferentially choose those institutions. Another explanation is that physicians practicing at an institution preferentially influence patient decision-making toward one procedure or another.

The Women's Health and Cancer Rights Act of 1998 guarantees coverage for reconstruction; however, this assumes that a reconstructive surgeon is available. Although all of the NCCN institutions had reconstructive surgeons on staff, it is possible that the supply of reconstructive surgeons at some centers was inadequate to meet the demand. As a result, opting for reconstruction could lead to a delay in surgery making this procedure less desirable. Alternatively, an abundant supply of reconstructive surgeons could lead breast surgeons to recommend mastectomy with reconstruction more frequently. One could postulate a number of reasons for this, including financial incentives for the department and the institution.

We also found that institutions where patients traveled longer distances to the nearest radiation facility had higher rates of mastectomy with reconstruction. Patients who live further from radiation facilities have been previously shown to have lower rates of both postmastectomy radiation and adjuvant radiation after BCS and our results are consistent.[38,40] This is likely due to the increase in logistical difficulty and travel time so that patients wishing to preserve a breast may preferentially opt for reconstruction over BCS.

We found no association with the supply of radiation oncologists and these results may be explained at least in part by the setting of our study. NCCN centers are tertiary care centers and approximately one-third of patients receive their radiation treatment at an institution closer to home.

There are 3 major limitations to this study. First, the observed relationships are associations and causality is plausible but cannot be proven using this data. Second, we did not account for variable clinical practices in assessing the availability of subspecialty care. Ideally, our analysis would account for the variability in the percent clinical effort as well as case mix. However, this information was not reliably attainable. Finally, this analysis includes only NCCN institutions, a consortium of academic medical centers that offer multidisciplinary cancer care and may not reflect broad American practice. However, because most NCCN institutions are structurally similar, not resource-constrained, and do not primarily serve rural or disadvantaged populations, the findings of this study likely underestimate the impact of the supply of subspecialists on patterns of care in more generalized practice.

There is substantial variation in the surgical treatment of early stage breast cancer across NCCN institutions. Although further population-based studies are needed, our findings are provocative and provide important new insight. There is essentially uniform agreement that the choice of surgical procedure for early stage breast cancer should be a preference-based decision and individualized to each patient. However, our results suggest that the institutional supply of subspecialty care, including the number of reconstructive surgeons, waiting time for reconstructive surgery and distance to radiation facilities, are associated with whether patients preferentially receive mastectomy with reconstruction or BCS. Physicians should be aware of this potential bias during discussions regarding surgical options for early stage breast cancer. Additionally, standardization of the content of these discussions and the use of decision aids, educational videos, and other educational material could help ensure that each woman has the information that she needs to make an informed choice.

Acknowledgments

Supported in part by grant P50 CA092203 from the National Cancer Institute to Dana-Farber Cancer Institute. Dr.Greenberg receives support from the American Surgical Association Foundation Fellowship.

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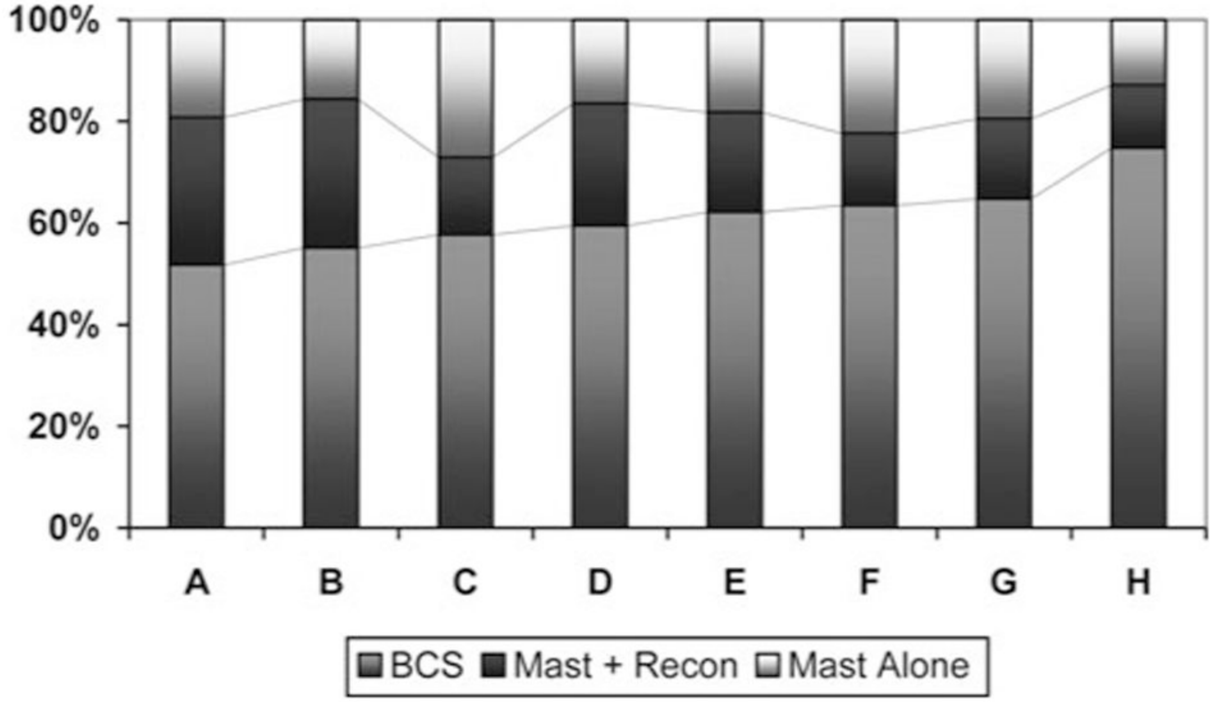

Figure 1.
The rates of breast conserving surgery, mastectomy alone, or mastectomy with reconstruction across NCCN centers. (N = 10,607, χ^2, $P < 0.0001$)

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Table 1

Description of Cohort Under Investigation. (N = 10,607)

Clinical Characteristics	N	%	Socio-demographic Characteristics	N	%
			Age at Diagnosis		
Co-morbidity score			<50 years	3691	34.8%
0	9759	92.0%	50 to <70 years	1976	51.4%
≥1	848	8.0%	≥70 years	2263	13.8%
			Health Insurance Type		
Body Mass Index (kg/m^2)			Managed care	6847	64.6%
<18.5 (Underweight)	158	1.5%	Indemnity	627	22.5%
18.5 to <25 (Normal)	4013	37.8%	Medicare	2390	5.9%
25 to <30 (Obese)	2990	28.2%	Medicaid/Indigent/Selfpay	630	5.9%
≥30 (Severely Obese)	2853	26.9%	Other	61	0.5%
Missing/unknown	593	5.6%	Missing/Unknown	51	0.6%
Stage at diagnosis					
DCIS	1858	17.5%			
I	4856	45.8%			
II	3893	36.7%			
			Educational Level		
HR status			Above high school	6007	56.6%
Positive	7449	70.2%	High School or less	2599	24.5%
Negative	2054	19.4%	Other	53	0.50%
Unknown	1104	10.4%	Missing/unknown	1948	18.4%
			Employment Status		
Tumor Size (in cm)			Employed/Student	5240	49.4%
No invasion	1858	17.5%	Homemaker	1687	15.9%
≤2.0	5982	56.4%	Unemployed	509	4.8%
>2.0 to 5.0	2343	22.1%	Retired	1988	18.7%
>5.0	67	0.63%	Other	304	2.9%
Missing/Unknown	357	3.4%	Missing/unknown	879	8.3%
			Median Household Income		
Nodal Status			Q1 (< $34,428)	2040	19.3%

Clinical Characteristics	N	%	Socio-demographic Characteristics	N	%
0 positive nodes	7263	68.5%	Q2 ($34,428 – <45,036)	2666	25.3%
1 – 3 positive nodes	2262	21.3%	Q3 ($45,036 – <59,918)	2640	25.0%
No nodal dissection	1082	10.2%	Q4 (≥$59,918)	2792	26.5%
			Missing/Unknown	469	4.4%
			Race/Ethnicity		
XRT			Caucasian	8803	83.0%
No XRT	4222	39.8%	Hispanic	601	5.7%
Post- BCS XRT	5743	54.1%	African American	749	7.1%
Postmastectomy XRT	642	6.1%	Asian	327	3.1%
Systemic therapy			Other	61	0.6%
Neoadj HT or chemo	1106	10.4%	Missing/Unknown	66	0.6%
Adjuvant HT alone	3913	36.9%			
Adjuvant chemo +/-HT	3687	34.8%			
None	1901	17.9%			
			Year of diagnosis		
			2000	1401	13.2%
Final Surgery			2001	1384	13.1%
BCS	6368	60.0%	2002	1560	14.7%
Mastectomy Alone	1976	18.6%	2003	1497	14.1%
Mastectomy + Recon	2263	21.3%	2004	1553	14.6%
			2005	1674	15.8%
			2006	1538	14.5%

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Table 2

Association of Patient Characteristics with Procedure Performed

Variable	Categories	BCS	Mastectomy	Mast + Recon	*p*[*]
Age at Diagnosis	<50	1829 (50%)	557 (15%)	1305 (35%)	<0.0001
	50–69	3541 (65%)	997 (18%)	911 (17%)	
	≥70	998 (68%)	422 (29%)	47 (3%)	
Co-morbidity Score	0	5803 (59%)	1773 (18%)	2183 (22%)	
	≥1	565 (67%)	203 (24%)	80 (9%)	<0.0001
Body Mass Index (kg/m^2)	Underweight	51 (32%)	40 (25%)	67 (42%)	
	Normal	2192 (55%)	736 (18%)	2085 (27%)	<0.0001
	Obese	1870 (63%)	534 (18%)	586 (20%)	
	Severely obese	1864 (65%)	566 (20%)	423 (15%)	
	Missing/Unknown	391 (66%)	100 (17%)	102 (17%)	
HR status	Positive	4579 (61%)	1346 (18%)	1524 (20%)	<0.0001
	Negative	1168 (57%)	465 (23%)	421 (21%)	
	Unknown	621 (56%)	165 (15%)	318 (29%)	
Final Tumor Size	No Invasion	1103 (59%)	240 (13%)	515 (28%)	<0.0001
	<2cm	3906 (65%)	928 (16%)	1148 (19%)	
	2.0 to 5.0cm	1154 (49%)	682 (29%)	507 (22%)	
	> 5.0cm	9 (13%)	47 (70%)	11 (16%)	
	Missing/unknown	196 (55%)	79 (22%)	82 (23%)	
Number of Positive Lymph Nodes	No axillary surgery	951 (88%)	44 (4%)	87 (8%)	<0.0001
	0	4359 (60%)	1296 (18%)	1608 (22%)	
	1–3	1058 (47%)	636 (28%)	568 (25%)	
Stage at Diagnosis	DCIS	1103 (59%)	240 (13%)	515 (28%)	<0.0001
	I	3311 (68%)	673 (14%)	872 (18%)	
	II	1954 (50%)	1063 (27%)	876 (23%)	
XRT	No XRT	625 (15%)	1580 (37%)	2017 (48%)	<0.0001
	Post-BCS XRT	5743 (100%)	-	-	
	Postmastectomy XRT	-	396 (62%)	246 (38%)	
Systemic Therapy	Neoadjuvant	595 (54%)	294 (27%)	217 (20%)	

Variable	Categories	BCS	Mastectomy	Mast + Recon	p^*
	Adjuvant Hormonal	2786 (71%)	559 (14%)	568 (15%)	<0.0001
	Adjuvant chemo	1980 (54%	768 (21%)	939 (25%)	
	No systemic	1007 (53%)	355 (19%)	539 (28%)	
Educational Level	Above high school	3518 (59%)	995 (17%)	1494 (25%)	
	High School or less	1571 (60%)	608 (23%)	420 (16%)	<0.0001
	Other	30 (57%)	9 (17%)	14 (26%)	
	Missing/Unknown	1249 (64%)	364 (19%)	335 (17%)	
Employment Status	Employed/Student	3047 (58%)	760 (15%)	1433 (27%)	
	Homemaker	970 (58%)	350 (21%)	367 (22%)	<0.0001
	Unemployed	281 (55%)	134 (26%)	94 (18%)	
	Retired	1309 (66%)	514 (26%)	165 (8%)	
	Other	185 (61%)	53 (17%)	66 (22%)	
	Missing/unknown	576 (66%)	165 (19%)	138 (16%)	
Median Household Income (byzip code)	<$34,428	1193 (58%)	447 (22%)	400 (20%)	
	$34,428 to 45,036	1632 (61%)	538 (20%)	496 (19%)	<0.0001
	$45,037 to 559,918	1562 (59%)	465 (18%)	613 (23%)	
	>$559,918	1728 (62%)	424 (15%)	640 (23%)	
	Missing/Unknown	223 (54%)	87 (21%)	103 (25%)	
Health Insurance Type	Managed care	3960 (58%)	1052 (15%)	1835 (27%)	
	Indemnity	394 (63%)	96 (15%)	137 (22%)	<0.0001
	Medicare	1610 (67%)	638 (27%)	142 (6%)	
	Medicaid/Indige/Self	340 (54%)	168 (27%)	122 (19%)	
	Other	39 (64%)	10 (16%)	12 (20%)	
	Missing/unknown	24 (47%)	12 (24%)	15 (29%)	
Race/Ethnicity	Caucasian	5399 (61%)	1558 (18%)	1846 (21%)	<0.0001
	Hispanic	304 (51%)	124 (21%)	173 (28%)	
	AA	433 (58%)	167 (22%)	149 (20%)	
	Asian	158 (48%)	101 (31%)	68 (21%)	
	Other	31 (51%)	14 (23%)	16 (26%)	
	Missing/unknown	43 (65%)	12 (18%)	11 (17%)	
Year of diagnosis*	2000	773 (55%)	287 (20%)	341 (24%)	<0.0001

Variable	Categories	BCS	Mastectomy	Mast + Recon	*P*[*]
	2001	791 (57%)	267 (19%)	326 (24%)	
	2002	922 (59%)	297 (19%)	3441 (22%)	
	2003	918 (61%)	282 (19%)	297 (20%	
	2004	971 (63%)	276 (18%)	306 (20%)	
	2005	1036 (62%)	291 (17%)	347 (21%)	
	2006	957 (62%)	276 (18%)	305 (20%)	

Percentages are row percentages or percent of patients with that characteristic who receive each type of surgical procedure. Percentages may not sum to 100% due to rounding.

[*] *P* value calculated using a χ-square test except year of diagnosis, which uses a Mantel–Hanszel test for trend.

Table 3

Predictors of Receipt of BCS or Mastectomy with Reconstruction.

Baseline Model	**R^2 = 0.249 C stat = 0.769 N = 7480**		
Variable Removed	R^2	ΔR^2	% ΔR^2
Age	0.184	0.065	26%
Institution	**0.213**	**0.036**	**14%**
Body Mass Index	0.229	0.020	8%
Systemic Tx	0.233	0.016	6%

Relative contribution of patient factors compared to institution in determining predictors of receipt of BCS compared to mastectomy with reconstruction. Patients undergoing mastectomy alone are not included in this model. Only variables that alter the R^2 by ≥5% are shown. The baseline model includes all variables listed as well as number of comorbidities, income level, final tumor size, number of positive lymph nodes, and HR status.