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Decision quality and regret with treatment decisions in women with breast cancer: Pre-operative breast MRI and breast density

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Abstract

Purpose: We evaluated self-report of decision quality and regret with breast cancer surgical treatment by pre-operative breast MRI use in women recently diagnosed with breast cancer.

Methods: We conducted a survey with 957 women aged 18+ with stage 0-III breast cancer identified in the Breast Cancer Surveillance Consortium. Participants self-reported receipt of pre-operative breast MRI. Primary outcomes were process measures in the Breast Cancer Surgery Decision Quality Instrument (BCS-DQI) (continuous outcome) and Decision Regret Scale (dichotomized outcomes as any/none). Generalized estimating equations with linear and logit

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AUTHOR DISCLOSURE OF CONFLICTS OF INTEREST

Karla Kerlikowske reports being a nonpaid consultant for GRAIL for STRIVE Study. Diana Miglioretti reports receiving an Honorarium from the Society for Breast Imaging for giving a keynote lecture. All other study authors report no conflicts of interest.

link were used to estimate adjusted associations between breast MRI and primary outcomes. All analyses were also stratified by breast density.

Results: Survey participation rate was 27.9% (957/3430). Study population was primarily >60 years, White, college educated, and diagnosed with early-stage breast cancer. Pre-operative breast MRI was reported in 46% of women. A higher proportion of women who were younger age (<50 years), commercially insured, and self-detected their breast cancer reported pre-operative breast MRI use. In adjusted analysis, pre-operative breast MRI use compared with no use was associated with a small but statistically significantly higher decision quality scores (69.5 vs 64.7, p-value=0.043) . Decision regret did not significantly differ in women who reported versus not reporting a pre-operative breast MRI (54.2% v. 48.7%, respectively, p-value=0.11). Study results did not vary when stratified by breast density for either primary outcome.

Conclusions and relevance: Breast MRI use in the diagnostic work-up of breast cancer does not negatively alter women's perceptions of surgical treatment decisions in early survivorship.

Clinical Trials Registration Number: NCT03029286.

Keywords

Breast MRI; breast cancer; mastectomy; decision quality; patient-reported outcomes; BCSC

INTRODUCTION

Pre-operative breast MRI use in women newly diagnosed with breast cancer has increased in the past 20 years as part of the diagnostic work-up for surgical evaluation for cancer treatment.[1,2] Based on the Breast Cancer Surveillance Consortium (BCSC) data linked to Medicare claims, pre-operative breast MRI increased more than 3-fold from 7.0% in 2005 to 24.3% in 2009 among women with invasive breast cancer.[2] National Comprehensive Cancer Network (NCCN) breast cancer guidelines state that pre-operative breast MRI could be used for staging evaluation or neoadjuvant systemic therapy evaluation.[3] However, NCCN guidelines also state breast MRI should not be used to guide local therapy decisions as no high-quality data demonstrate improvements in local recurrence or survival.[4,5] A decision-analytic model demonstrated that preoperative breast MRI conferred no additional advantage to routine imaging evaluation for women with early stage breast cancer.[6] Study authors concluded that preoperative breast MRI could lead to worse patient outcomes as more women might unnecessarily undergo mastectomy, if they were uncertain about surgical choice.

To date, limited evidence exists regarding imaging and treatment decisions on patient-centered outcomes, including outcomes such as decision quality with respect to initial surgery, more extensive surgery due to re-excision/reoperation, and cancer worry and fear.[7-9] The diagnostic work-up period is a particularly vulnerable time for women newly diagnosed with breast cancer. In a recent systematic review, the diagnostic work-up period is described as one of heightened psychological distress for women, with short- and long-term implications for mental health, treatment decision-making, and future screening participation.[10,11] Pre-operative breast MRI use could lead some women to negatively experience their surgical treatment decision, because use of breast MRI is associated with

delays in cancer surgery and higher overall costs.[12] However, some women, in particular women with dense breasts, might feel reassured with pre-operative breast MRI use to guide their surgical treatment decision if they fear missed cancer. Women with dense breasts are more likely to experience masking of breast cancer,[13] and have an increased risk of contralateral breast cancer compared to women with non-dense breasts,[14] which would support these concerns. To date, few studies have evaluated women's perspectives regarding the use of breast MRI and the association with decision quality as women transition into early survivorship.

Our objective was to evaluate decision quality and regret with breast cancer surgical treatment decisions by pre-operative breast MRI use. We stratified all analyses by breast density to determine if observed results differed by women with and without dense breasts.

METHODS

Setting

The BCSC is a network of breast imaging registries that link data from community-based radiology facilities to state or Surveillance, Epidemiology, and End Results (SEER) cancer registries and pathology databases.[15] This study used data from seven registries: Carolina Mammography Registry, Kaiser Permanente Washington, New Hampshire Mammography Network, San Francisco Mammography Registry, Sacramento Area Breast Imaging Registry, Metro Chicago Breast Cancer Registry, and Vermont Breast Cancer Surveillance System.[16] The BCSC collects demographic and clinical data at imaging exams conducted during routine clinical care. Registries send standardized data to a Statistical Coordinating Center for pooling, linking of relevant data files, and statistical analysis.

Each registry and the Statistical Coordinating Center received institutional review board approval for passive permission, or a waiver of written informed consent to identify and conduct an online survey. All procedures were Health Insurance Portability and Accountability Act compliant. The study authors had control of the data and information submitted for publication.

Participants

Eligible participants were aged 18 years or older at diagnosis of incident breast cancer (stage 0-III) and diagnosed within 6-18 months at identification for recruitment from a BCSC registry. All participants had a digital mammogram or breast tomosynthesis scan within five years of their breast cancer diagnosis documented within a BCSC registry.

Recruitment

BCSC registries contacted 3,430 potentially eligible participants by US postal service to invite them to participate in a survey. Survey recruitment and completion ran from December 2017 through January 2020. All participants were invited to complete the online survey via a secure web portal using a unique identification number and password. Additionally, six of the seven registries offered a paper-based survey in their invitation letters and provided pre-paid envelope to return survey. One registry also offered participants

survey completion via telephone. Potential participants were reminded three times to complete their survey. Six registries included $2 bills in their recruitment letters as an incentive, to improve participant response.[17] As a further incentive, participants from five registries were entered for a chance to win a $100 gift card with one winner per registry.

Measures

Study participants completed a one-time multi-part question survey to ascertain receipt of pre-operative imaging and patient-reported outcomes of decision quality and regret.

Pre-operative breast MRI—Women self-reported receipt of different breast imaging modalities used prior to their first surgical treatment. Women were asked "Which tests did you receive to screen for and diagnose your breast cancer?" Women could mark any imaging that applied. Potential responses included mammogram-digital, mammogram-tomosynthesis, mammogram but don't know what type, ultrasound, and breast MRI. Women who affirmatively marked receipt of breast MRI were categorized as "yes" to pre-operative breast MRI.

Patient-reported outcome measures—Our primary outcomes assessed decision quality and regret. We used the Decision process score derived from the Breast Cancer Surgery Decision Quality Instrument (BCS-DQI) developed by Sepucha et al.[18-20] Seven items assessed the (i) discussion of options of mastectomy and lumpectomy (yes/no), (ii) amount of discussion of pros of each surgery (a lot/some/a little/not at all), (iii) amount of discussion of cons of each surgery (a lot/some/a little/not at all) and (iv) discussion of patients' goals and treatment preferences (yes/no). Each item with a response of 'yes' or 'a lot/some' received one point, and all other responses received no points. A total decision process score was calculated by summing the points, dividing by seven, and multiplying by 100, resulting in scores from 0 to 100% with higher scores indicating more shared decision making. Respondents need to have answered >50% of questions to calculate the score.

We assessed the Decision Regret Scale developed by O'Connor et al,[21] as a *measure of distress or remorse after a healthcare decision (i.e., breast cancer surgery for this study)* using 5 multiple choice items. Scores were converted to a 0-100 scale, with higher scores indicating more decisional regret. Overall, a high proportion of women reported no Decision Regret and overall mean was low (mean 9.9/100 in no pre-operative breast MRI group). Hence, Decision Regret is reported as a binary measure of any regret (score>0) versus no regret (score 0).

To explore associations in which pre-operative breast MRI influence women's perceptions of breast cancer surgery decisions, participants also self-reported as secondary outcomes: a) treatment decisions considerations (i.e., How important was the cost of treatment in deciding what treatment you would receive for your breast cancer? How important was minimizing time missed from work or from other responsibilities in deciding what treatment you would receive for your breast cancer?); b) cancer worry measured by the Lerman Cancer Worry scale;[22] and c) uncertainty with treatment decision measured by Decisional Conflict Scale.[23]

Breast density prior to breast cancer diagnosis—We linked study participants to breast density measure captured during routine screening mammography and documented within a BCSC registry before breast cancer diagnosis. Breast density was categorized according to the American College of Radiology's (ACR) Breast Imaging-Reporting and Data System (BI-RADS).[24] Almost entirely fatty and scattered fibroglandular densities were considered “non-dense” breasts, and heterogeneously dense and extremely dense were considered “dense” breasts. Breast density was the only analytic variable ascertained from BCSC data systems.

Demographics and clinical characteristics—Participants self-reported demographics (i.e., age, race/ethnicity, living arrangement), education and socioeconomic status (i.e., educational attainment, working status, health insurance), breast cancer characteristics (i.e., mode of primary cancer detection, stage at diagnosis), and treatment (i.e., first surgical treatment, subsequent treatment).

Statistical Analysis

We calculated descriptive statistics for all variables by calculating frequencies for categorical variables and means with standard deviations for continuous variables. The analytic dataset excluded participants with missing report of pre-operative imaging (n=51) or without a measure of breast density (n=25). For our two primary outcomes, we tested the distribution as continuous outcomes and determined that responses were not normally distributed. Therefore, we used nonparametric Wilcoxon rank-sum test for comparing continuous outcome (BCS-DQI Decision process score) between two groups (yes vs no pre-operative breast MRI). We used Chi-square test for differences between groups for categorical variables and a binary outcome (Decision Regret Scale).

Models were estimated using the SAS PROC GENMOD procedure with linear link to analyze non-normal continuous outcomes and logit link for binary outcomes (SAS version 9.4, Cary, NC). Covariates considered are described in Table 1 and Table 2. Breast density, pre-operative breast MRI, and age at survey were identified *a priori* and included in all multivariable models. To select additional covariates for inclusion in adjusted models, we used the GLMSELECT procedure in SAS with the stepwise variable selection method (entry $p<0.1$, removal $p>0.05$). The only additional covariate that qualified for inclusion was cancer worry. In addition to age at survey, cancer worry, breast density, and pre-operative breast MRI, final models included a product term between breast density and pre-operative breast MRI. Statistical significance was defined as $p<0.05$ based on a 2-sided hypothesis test with no adjustments made for multiple comparisons.

RESULTS

Overall survey participation rate was 27.9% among eligible respondents (957 eligible participants with complete data/3,430 contacted participants). Majority of surveys were completed online (87%), followed by 13% completed as paper surveys. Less than 1% were completed by phone.

Overall study population was primarily >60 years, White, college educated, and diagnosed with early-stage breast cancer. Among respondents, 45.8% reported pre-operative breast MRI (438/957) (Table 1). Women with dense breasts were more likely to report a pre-operative breast MRI compared to women with non-dense breasts (51% vs. 40%, respectively) (Table 1).

Compared with women who did not receive pre-operative breast MRI, women who received a pre-operative breast MRI were more likely to be <50 years old, commercially insured, and to have self-detected their breast cancer. Women who received pre-operative breast MRI were also more likely to report a mastectomy as their first cancer surgery (Table 1). Patterns remained similar when stratified by breast density for most characteristics, except first cancer surgery. lower proportion of women with non-dense breasts reported mastectomy (25%) compared with women with dense breasts (36%) in those who received a pre-operative breast MRI.

For most women overall, neither cost nor time missed from work were an important consideration in cancer treatment decisions (Table 2). Self-reported cancer worry was low overall. Overall, measures of cancer worry were clinically similar but statistically significantly different ($p<0.002$) among women who received (11.6) vs. did not receive (10.8) pre-operative breast MRI in univariate analysis. In stratified analyses by breast density, patterns observed in the overall population remained similar.

In multivariable adjusted models, pre-operative breast MRI use was associated with improved decision quality relative to women who did not receive breast MRI (mean 69.5 vs 64.7, absolute difference 4.8, $p=0.004$) (Table 3). Study results remained similar when stratified by breast density; however, among women with non-dense breasts, the difference in decision quality widened between women who did and did receive pre-operative breast MRI (absolute difference 6.0, $p=0.016$). No statistically significant interaction by breast density group was observed (p-interaction=0.44).

Univariate associations between pre-operative breast MRI use were associated with greater decision regret (53% for users and 47% among non-users) (Table 4). Although the magnitude of the effect remained similar, there was no difference in decision regret after multivariable adjustment (54.2% vs 48.7%, $p=0.11$). Further, there were no differences in study results when stratified by breast density and no statistically significant interaction (p-interaction=0.71).

DISCUSSION

Our study is among the first to evaluate women's perceptions of decision quality and regret related to breast cancer surgery by pre-operative breast MRI receipt and clinical breast density status. Overall, our results indicate that using pre-operative breast MRI is associated with a small increase in the decision quality measured as a process score relative to women who did not receive pre-operative breast MRI. Further, we found no association between pre-operative breast MRI use and decision regret. Similar patterns of pre-operative breast MRI and decision quality and regret were observed when stratified by breast density,

indicating that breast density does not modify the observed relationship among women in early breast cancer survivorship. Our study results refute prior suggestions that use of breast MRI could be associated with worse patient outcomes.[6]

Higher scores in decision quality indicate improvement in surgical treatment decision making with providers.[18] Decision quality measured in the study population is similar to other breast cancer survivor populations (67.5%[25]), which is indicative of moderate involvement in decision-making. Given that our overall measure aligns with prior reports, it is uncertain whether the absolute difference in scores results in clinically meaningful differences based on receipt of breast MRI. These measure differences equate to answering one additional question affirmatively, on average, in women who received pre-operative breast MRI compared to women who did not receive breast MRI. Our cross-sectional survey was conducted after decisions and cancer surgery were completed. It was not feasible to evaluate whether higher decision quality was influenced by pre-operative breast MRI alone or by other aspects of breast cancer treatment decision making such as the use of decision aids,[26] and/or factors related to the surgeon, which were beyond the focus of our study. A recent trial of breast cancer surgery conversation aids has reported surgeon-specific variation in decision quality.[27] It is plausible that receipt of pre-operative breast MRI could lead to more detailed discussions regarding surgical treatment decisions, given the additional imaging results to evaluate for extent of disease could alter initial surgical plans. Nonetheless, clinicians should provide comprehensive shared-decision making with use of decision aids to all women, regardless of imaging received.

Overall, nearly half of women reported some low-level of decision regret with breast cancer treatment. The proportion reporting some regret did not differ by receipt of breast MRI nor when stratified by breast density. Our study population reported a higher burden of some decision conflict, among women who considered both lumpectomy and mastectomy. Prior studies documented 8-27% women with treated breast cancer experience decision conflict,[28] when women considered bilateral mastectomy with only one affected breast. Contralateral mastectomy is associated with increased cancer distress, poor body image, and decreased self-reported quality of life.[29] As a cross-sectional study, we do not have additional details about the context in which women considered surgical treatment to determine what led to elevated reports of decision regret. Our measure of decision regret could be elevated by categorizing women with any reported regret, even if low level. Further, these perspectives will reflect the experiences of the type of women participating in the survey (i.e., older White women with health insurance) in our survey rather than of the more heterogenous population of women with treated breast cancer. Since pre-operative breast MRI is associated with increased rates of mastectomy[30] and might have been relevant in contributing to women's perceptions, additional studies are warranted in understanding the impact of breast MRI on decision regret in more diverse populations.

We stratified all analyses by breast density, which could be a driver of additional imaging with breast MRI.[31] Our study results showed that a higher proportion of women with dense breasts received breast MRI than women with non-dense breasts. Use of breast MRI is associated with higher breast biopsy rates without additional cancer detection among women with dense breasts.[32] However, regardless of potentially more intense work-up

among women with dense breasts, we observed no meaningful differences between women with dense breast versus with non-dense breasts in the association between breast MRI on decision quality or regret even when accounting for cancer worry.

Our study has several strengths including a national sample of women, a sufficient sample to measure differences by both pre-operative breast MRI and clinically measured breast density, and validated decision quality and decisional regret measures.[18 19-21] However, there remain some limitations. First, our pre-operative breast MRI definition was defined by asking women to report what tests they received to "screen for and diagnosis their breast cancer", which may include some screening breast MRI. Breast MRIs received for screening vs. as a preoperative exam are the same procedure, the relevant scan is still within the pre-operative window considered for exposure. Additionally, we are unaware of studies that have reported the accuracy of breast imaging received during the diagnostic work-up vs. self-report. However, prior studies have demonstrated high concordance of women's self-report of receipt of breast cancer treatment.[33] Misclassification of study exposure is likely low, given these findings. We assessed perceptions about 6-18 months after diagnosis, which might have attenuated women's responses. Previous reports assessing longitudinal Breast Cancer Surgery-Decision Quality Instrument one year after diagnosis were valid relative to 1 month after diagnosis.[18] Given this, recall bias is likely minimized given the timeframe of outcome ascertainment. Nonetheless, women might have perceived their experiences differently if they had experienced breast cancer recurrence or another breast cancer event, data not collected. By restricting the population of women self-reporting outcomes to within 18 months of the primary breast cancer diagnosis, we minimized the likelihood that a recurrence would have occurred at the time women responded to the survey. Our study participation might not reflect the experiences of all women diagnosed stage 0-III breast, potentially limiting generalizability of study findings. Differences in both study outcomes might differ among more diverse women and warrant further study. Given the scarcity of studies on patient reported outcomes, our results fill a critical gap in understanding women's perceptions of the downstream consequences for women on the use of pre-operative breast MRI.

Overall, use of pre-operative breast MRI was associated with slightly improved decision quality for breast cancer treatment without impacting decision regret. Breast MRI use in the diagnostic work up of breast cancer was not associated with negative perceptions of cancer treatment decisions early in survivorship. Breast MRI use in the diagnostic work-up of breast cancer does not negatively alter women's perceptions of surgical treatment decisions in early survivorship. Further studies should evaluate whether these studies findings hold or vary in more diverse women treated for breast cancer.

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its findings and conclusions, are solely those of the authors and do not necessarily represent the views of the Patient-Centered Outcomes Research Institute (PCORI), its Board of Governors or Methodology Committee, nor those of the National Cancer Institute or the National Institutes of Health. We thank the participating women, mammography facilities, and radiologists for the data they have provided for this study. You can learn more about the BCSC at: http://www.bcsc-research.org/.

DATA SHARING

The datasets generated during and analyzed during the current study are not publicly available until remaining analyses are complete but may be available on reasonable request from the senior author Dr. Anna Tosteson at anna.n.a.tosteson@dartmouth.edu.

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TABLE 1.

Self-reported characteristics of study population by receipt of pre-operative breast MRI, overall and stratified by breast density.

	Overall		Non-dense breasts*		Dense breasts*	
	Pre-operative breast MRI		Pre-operative breast MRI		Pre-operative breast MRI	
	Yes	No	Yes	No	Yes	No
Characteristic	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Total	438	519	167	254	271	265
Demographics						
Age, years						
< 50	69 (16%)	50 (10%)	11 (7%)	12 (5%)	58 (21%)	38 (14%)
50-59	113 (26%)	112 (22%)	27 (16%)	50 (20%)	86 (32%)	62 (23%)
60-69	167 (38%)	184 (35%)	78 (47%)	98 (39%)	89 (33%)	86 (32%)
70+	87 (20%)	168 (32%)	49 (29%)	90 (35%)	38 (14%)	78 (29%)
Race and ethnicity						
White, non-Hispanic	376 (86%)	453 (87%)	145 (87%)	222 (87%)	231 (85%)	231 (87%)
Black, non-Hispanic	25 (6%)	19 (4%)	10 (6%)	9 (4%)	15 (6%)	10 (4%)
Asian/Native Hawaiian or Other Pacific Islander	17 (4%)	16 (3%)	5 (3%)	5 (2%)	12 (4%)	11 (4%)
Hispanic	14 (3%)	22 (4%)	4 (2%)	13 (5%)	10 (4%)	9 (3%)
Native American/Mixed/Other	4 (1%)	5 (1%)	1 (1%)	4 (2%)	3 (1%)	1 (0%)
Education						
High school or less	45 (10%)	65 (13%)	21 (13%)	43 (17%)	24 (9%)	22 (8%)
Some college	125 (29%)	164 (32%)	58 (35%)	94 (37%)	67 (25%)	70 (27%)
College graduate	100 (23%)	104 (20%)	33 (20%)	37 (15%)	67 (25%)	67 (26%)
Graduate school	166 (38%)	181 (35%)	53 (32%)	78 (31%)	113 (42%)	103 (39%)
Rural/urban residence						
Rural	43 (10%)	53 (10%)	19 (11%)	30 (12%)	24 (9%)	23 (9%)
Urban	395 (90%)	466 (90%)	148 (89%)	224 (88%)	247 (91%)	242 (91%)
Work status						
Working	235 (54%)	242 (47%)	66 (40%)	105 (42%)	169 (62%)	137 (52%)

	Overall		Non-dense breasts*		Dense breasts*	
	Pre-operative breast MRI		Pre-operative breast MRI		Pre-operative breast MRI	
	Yes	No	Yes	No	Yes	No
Characteristic	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Retired	183 (42%)	252 (49%)	92 (55%)	135 (53%)	91 (34%)	117 (44%)
Unemployed/Disabled	15 (3%)	18 (3%)	7 (4%)	10 (4%)	8 (3%)	8 (3%)
Insurance status						
Commercial	266 (61%)	251 (48%)	75 (45%)	103 (41%)	191 (70%)	148 (56%)
Medicare	164 (37%)	258 (50%)	88 (53%)	145 (57%)	76 (28%)	113 (43%)
Medicaid	6 (1%)	8 (2%)	3 (2%)	4 (2%)	3 (1%)	4 (2%)
First degree family history of breast cancer						
Yes	136 (31%)	144 (28%)	47 (28%)	60 (24%)	89 (33%)	84 (32%)
No	297 (68%)	364 (70%)	117 (70%)	187 (74%)	180 (66%)	177 (67%)
I don't know	5 (1%)	10 (2%)	3 (2%)	6 (2%)	2 (1%)	4 (2%)
Breast cancer diagnosis						
Mode of detection						
Self-detected	127 (29%)	107 (21%)	37 (22%)	46 (18%)	90 (33%)	61 (23%)
Screening mammogram	269 (61%)	379 (73%)	123 (74%)	190 (75%)	146 (54%)	189 (71%)
Clinical detection	41 (9%)	31 (6%)	7 (4%)	16 (6%)	34 (13%)	15 (6%)
Stage at diagnosis						
DCIS	81 (18%)	105 (20%)	39 (23%)	57 (22%)	55 (20%)	69 (26%)
I	234 (53%)	268 (52%)	75 (45%)	129 (51%)	128 (47%)	107 (40%)
II	86 (20%)	99 (19%)	39 (23%)	47 (19%)	60 (22%)	62 (23%)
III	24 (5%)	28 (5%)	7 (4%)	11 (4%)	21 (8%)	16 (6%)
Not certain	13 (3%)	19 (4%)	7 (4%)	10 (4%)	7 (3%)	11 (4%)
Time from diagnosis to first cancer surgery, months						
<1	81 (18%)	144 (28%)	26 (16%)	78 (31%)	55 (20%)	66 (25%)
1-2	200 (46%)	238 (46%)	80 (48%)	115 (45%)	120 (44%)	123 (46%)
2-3	84 (19%)	66 (13%)	39 (23%)	29 (11%)	45 (17%)	37 (14%)

	Overall		Non-dense breasts*		Dense breasts*	
	Pre-operative breast MRI		Pre-operative breast MRI		Pre-operative breast MRI	
	Yes	No	Yes	No	Yes	No
Characteristic	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
>3	67 (15%)	57 (11%)	19 (11%)	25 (10%)	48 (18%)	32 (12%)
First cancer surgery						
Lumpectomy	294 (67%)	397 (77%)	122 (73%)	208 (83%)	172 (63%)	189 (71%)
Mastectomy	140 (32%)	108 (21%)	42 (25%)	39 (15%)	98 (36%)	69 (26%)
No surgical treatment	4 (1%)	12 (2%)	3 (2%)	5 (2%)	1 (0%)	7 (3%)
Additional treatment received after first cancer surgery						
Mastectomy	29 (7%)	32 (6%)	9 (6%)	17 (7%)	20 (7%)	15 (6%)
Breast reconstruction surgery	89 (21%)	46 (9%)	29 (18%)	12 (5%)	60 (22%)	34 (13%)
Radiation therapy	264 (61%)	338 (67%)	103 (63%)	167 (68%)	161 (60%)	171 (66%)
Hormone therapy	212 (49%)	241 (48%)	74 (45%)	113 (46%)	138 (51%)	128 (50%)
Chemotherapy	114 (26%)	107 (21%)	40 (25%)	51 (21%)	74 (27%)	56 (22%)
No additional treatment	41 (9%)	56 (11%)	22 (13%)	26 (11%)	19 (7%)	30 (12%)

*Breast density was collected from the clinical interpretation based on most recent mammogram before cancer diagnosis documented in BCSC.

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TABLE 2:

Self-report of breast cancer treatment decision, cancer worry and conflict associated with pre-op breast MRI, overall and by breast density

	Overall			Non-dense breasts			Dense breasts		
	Pre-operative breast MRI			Pre-operative breast MRI			Pre-operative breast MRI		
	Yes	No		Yes	No		Yes	No	
Characteristic	**N (%)**	**N (%)**	**p-value***	**N (%)**	**N (%)**	**p-value***	**N (%)**	**N (%)**	***p-value**
Treatment decision									
How important was the **cost** of treatment in deciding what treatment you would receive for your breast cancer?			0.15			0.044			0.98
Not at all	297 (68%)	370 (71%)		109 (65%)	183 (72%)		188 (69%)	187 (71%)	
Slightly	64 (15%)	55 (11%)		28 (17%)	26 (10%)		36 (13%)	29 (11%)	
Moderately	32 (7%)	32 (6%)		13 (8%)	12 (5%)		19 (7%)	20 (8%)	
Very	12 (3%)	20 (4%)		5 (3%)	13 (5%)		7 (3%)	7 (3%)	
Extremely	22 (5%)	20 (4%)		8 (5%)	6 (2%)		14 (5%)	14 (5%)	
I prefer not to answer	9 (2%)	20 (4%)		3 (2%)	13 (5%)		6 (2%)	7 (3%)	
How important was **minimizing time missed from work** or from other responsibilities in deciding what treatment you would receive for your breast cancer?			0.44			0.67			0.79
Not at all	250 (57%)	326 (63%)		107 (64%)	170 (67%)		143 (53%)	156 (59%)	
Slightly	83 (19%)	79 (15%)		23 (14%)	31 (12%)		60 (22%)	48 (18%)	
Moderately	42 (10%)	52 (10%)		12 (7%)	25 (10%)		30 (11%)	27 (10%)	
Very	33 (8%)	30 (6%)		13 (8%)	13 (5%)		20 (7%)	17 (6%)	
Extremely	25 (6%)	25 (5%)		10 (6%)	11 (4%)		15 (6%)	14 (5%)	
I prefer not to answer	4 (1%)	5 (1%)		1 (1%)	3 (1%)		3 (1%)	2 (1%)	
Cancer worry scale[≠]									
Mean (SD)	11.6 (3.7)	10.8 (3.5)		11.2 (3.6)	10.9 (3.5)		11.8 (3.7)	10.7 (3.6)	
Median	11	10	0.002	11	10	0.38	11	10	<0.001
Min, Max	4, 24	2, 24		4, 22	2, 21		6, 24	3, 24	

	Overall			Non-dense breasts			Dense breasts		
	Pre-operative breast MRI			Pre-operative breast MRI			Pre-operative breast MRI		
	Yes	No		Yes	No		Yes	No	
Characteristic	**N (%)**	**N (%)**	**p-value***	**N (%)**	**N (%)**	**p-value***	**N (%)**	**N (%)**	***p-value**
Q1, Q3	9, 14	8, 13		8, 13	8, 13		9, 14	8, 13	
Decisional conflict scale§									
Mean (SD)	6.0 (14.3)	6.2 (14.4)		5.7 (14.6)	6.1 (13)		6.2 (14.1)	6.3 (15.7)	
Median	0	0	0.23	0	0	0.084	0	0	0.96
Min, Max	0, 80	0, 95		0, 75	0, 85		0, 80	0, 95	
Q1, Q3	0, 0	0, 5		0, 0	0, 10		0, 5	0, 5	

*p-values were based on Chi-square test for categorical variables and two-sample nonparametric Wilcoxon rank-sum test for continuous variables.

‡The Lerman cancer worry scale score ranges from 6 to 24 with higher scores indicating more frequent worries about cancer.

§Decisional Conflict Scale scores range from 0 to 100, with 0 indicating extremely certain about best choice and 100 indicating extremely uncertain about best choice.

TABLE 3.

The association of pre-operative breast MRI on unadjusted and adjusted outcomes on the Breast Cancer Surgery Decision Quality Instrument*, overall and by breast density.

	Overall			Non-dense breasts			Dense breasts		
	Pre-operative breast MRI		p-value	Pre-operative breast MRI		p-value	Pre-operative breast MRI		p-value
	Yes	No		Yes	No		Yes	No	
Unadjusted			**<0.001**			**0.007**			**0.041**
Mean (SD)	69.4 (24.5)	63.7 (25.8)		69.0 (24.8)	62.6 (24.9)		69.7 (24.4)	64.8 (26.6)	
Median	71	71		71	57		71	71	
Q1, Q3	57, 86	43, 86		57, 86	43, 86		57, 86	43, 86	
Adjusted≠									
Mean (SE)	69.5 (1.28)	64.7 (1.18)	**0.004**	70.1 (2.03)	64.1 (1.67)	**0.016**	68.9 (1.54)	65.4 (1.57)	0.11

Abbreviations: SD, standard deviation; SE, standard error

*The Decision Quality Instrument - decision process score ranges from 0-100%, with higher scores indicating more shared decision making.

≠Primary model adjusted for: age at survey, cancer worry, and breast density. Stratified model was adjusted for age at survey, cancer worry, breast density, pre-operative breast MRI, and interaction between density and pre-operative breast MRI.

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TABLE 4.

The association of pre-operative breast MRI on unadjusted and adjusted outcomes on the Decision Regret Scale*, overall and by breast density.

	Overall			Non-dense breasts			Dense breasts		
	Pre-operative breast MRI		p-value	Pre-operative breast MRI		p-value	Receipt of pre-operative breast MRI		p-value
	Yes	No		Yes	No		Yes	No	
Unadjusted			**0.049**			0.47			**0.037**
None	204 (47%)	276 (53%)		76 (46%)	126 (50%)		128 (47%)	150 (57%)	
Any	234 (53%)	243 (47%)		91 (54%)	128 (50%)		143 (53%)	115 (43%)	
Adjusted≠			0.11			0.41			0.13
None	45.8%	51.3%		43.4%	47.6%		48.8%	55.0%	
Any	54.2%	48.7%		56.6%	52.4%		51.2%	45.0%	

*Decision regret scale is dichotomized as any (Score >0) versus none (0).

≠Primary model adjusted for: age at survey, cancer worry, and breast density. Stratified model was adjusted for age at survey, cancer worry, breast density, pre-operative breast MRI, and interaction between density and pre-operative breast MRI.