Original Research

Adherence to Guidelines for Breast Surveillance in Breast Cancer Survivors

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Abstract

Background: Guidelines recommend annual mammography after curative-intent treatment for breast cancer. The goal of this study was to assess contemporary patterns of breast imaging after breast cancer treatment. **Methods:** Administrative claims data were used to identify privately insured and Medicare Advantage beneficiaries with nonmetastatic breast cancer who had residual breast tissue (not bilateral mastectomy) after breast surgery between January 2005 and May 2015. We calculated the proportion of patients who had a mammogram, MRI, both, or neither during each of 5 subsequent 13-month periods. Multinomial logistic regression was used to assess associations between patient characteristics, healthcare use, and breast imaging in the first and fifth years after surgery. **Results:** A total of 27,212 patients were followed for a median of 2.9 years (interquartile range, 1.8–4.6) after definitive breast cancer surgery. In year 1, 78% were screened using mammography alone, 1% using MRI alone, and 8% using both tests; 13% did not undergo either. By year 5, the proportion of the remaining cohort (n=4,790) who had no breast imaging was 19%. Older age was associated with an increased likelihood of mammography and a decreased likelihood of MRI during the first and fifth years. Black race, mastectomy, chemotherapy, and no MRI at baseline were all associated with a decreased likelihood of both types of imaging. **Conclusions:** Even in an insured cohort, a substantial proportion of breast cancer survivors do not undergo annual surveillance breast imaging, particularly as time passes. Understanding factors associated with imaging in cancer survivors may help improve adherence to survivorship care guidelines.

J Natl Compr Canc Netw 2018;16(5):526–534
doi: 10.6004/jnccn.2018.7001

Breast cancer survivors who have residual breast tissue are recommended to undergo mammographic surveillance annually. ASCO, the American Cancer Society (ACS), and NCCN recommend annual mammograms beginning at 1 year after the mammogram that led to the cancer diagnosis, and at least 6 months after the completion of postlumpectomy radiation.[1–3] It has been shown that mammographic detection of asymptomatic recur-

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Submitted October 31, 2017; accepted for publication January 2, 2018.

Dr. Mougalian has disclosed that she has stock or other ownership interest with Gilead Services Inc. and Roche Holdings Ltd., has a consulting or advisory role with Eisai Pharmaceuticals and Hylapharm LLC, and has received research funding with NCCN/Pfizer. Dr. Lemaine has disclosed that she has stock or other ownership interest with Exact Sciences, has received honoraria from ACEL RX, has a consulting or advisory role with ACESE RX and Lifecell, has received research funding from Allergan, and has had travel expenses associated with activities listed herein paid by Bonti, ACEL RX, and Lifecell. Dr. Vachon has disclosed that she has a leadership role with and has received research funding from Grail Inc. The remaining authors have disclosed that they have no financial interests, arrangements, affiliations, or commercial interests with the manufacturers of any products discussed in this article or their competitors.

Dr. Ruddy and Ms. Sangaralingham were supported by an NCCN Young Investigator Award (PI: Ruddy).

Author contributions: *Study concept:* Ruddy. *Study design:* Ruddy, Sangaralingham, Freedman, Mougalian, Neuman, Greenberg, Jemal, Gross, Shah. *Funding acquisition:* Ruddy. *Data analysis:* Sangaralingham. *Interpretation of results:* Ruddy, Freedman, Mougalian, Neuman, Greenberg, Jemal, Duma, Haddad, Lemaine, Ghosh, Hieken, Hunt, Vachon, Gross, Shah. *Manuscript preparation:* Ruddy. *Critical revision and final approval:* All authors.

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rences is associated with earlier disease stage and increased overall survival.[4–7]

In contrast to the consistent recommendation for mammography of residual breast tissue in this setting, ACS, ASCO, and NCCN state that there is insufficient evidence to recommend for or against MRI for routine breast cancer surveillance.[1–3] According to guidelines, breast MRI should never be used instead of mammography, and only in addition to mammograms for those with a >20% lifetime breast cancer risk based on very strong family history, with a known cancer predisposition syndrome, or who had radiation therapy to the chest between ages 10 and 30 years. Evidence to support MRIs among breast cancer survivors is limited,[8,9] but a recent case series study suggested that MRI may be more specific in breast cancer survivors than in women with only genetic risk or a strong family history.[10]

Real-world adherence to breast imaging guidelines among mixed-age women with breast cancer has been understudied in the United States. In women aged >65 years diagnosed with stage I–II breast cancer between 1992 and 1999, a SEER-Medicare analysis revealed that only 78% underwent mammography during months 7 to 18 after diagnosis, and only 57% had mammography yearly within 3 years.[11] Patients who continued to see oncology specialists and who were younger, white (vs black), and living in certain regions were more likely to undergo mammography. Other studies have shown similar findings in older patients diagnosed more than a decade ago, generally with only 3 to 4 years of follow-up.[12–17] A recent study using survey responses from 1,040 breast cancer survivors aged >65 years in the National Health Interview Survey found that 78.9% self-reported receipt of a mammogram in the prior 12 months, including only 86% of the 365 who had a life expectancy >10 years.[18] We aimed to expand on this work by assessing rates and predictors of breast MRI and mammography in a modern cohort of mixed-age breast cancer survivors, and investigating how rates of imaging changed as time passed after diagnosis.

Methods

Data Source

A retrospective analysis was conducted using the OptumLabs Data Warehouse, a large US database that includes administrative claims data from privately insured patients and Medicare Advantage enrollees across all 50 states and of all ages and ethnic and racial groups. Administrative claims are available on >100 million enrollees and include medical claims for professional (eg, physician), facility (eg, hospital), and outpatient pharmacy claims.[19,20] The Mayo Clinic Institutional Review Board deemed this study exempt from review.

Study Population

We identified all women with newly diagnosed nonmetastatic breast cancer treated with breast surgery (lumpectomy or unilateral mastectomy) between January 1, 2005, and May 1, 2015, using previously validated claims-based algorithms.[21,22] Patients were required to be age ≥18 years and have at least 12 months of continuous health plan coverage before their first breast cancer diagnosis and for 13 months following the definitive breast surgery (without diagnosis of metastatic breast cancer during that period). Those who received bilateral mastectomy within 18 months of their original diagnosis were excluded from this cohort (n=4,848). All types of systemic therapy (or lack thereof) were allowed.

Independent Variables

For each patient, we assessed demographic and clinical characteristics at baseline diagnosis of breast cancer, including age, sex, race/ethnicity, geographic region (characterized as Northeast, Midwest, South, West, and other/unknown), local therapy type (lumpectomy followed by radiation, lumpectomy alone, mastectomy alone, mastectomy followed by radiation), receipt of chemotherapy, whether a primary care provider (PCP) or hematology/oncology visit occurred during the year of follow-up, and total number of medical comorbidities captured by ICD-9 codes on claims occurring within 12 months before breast cancer diagnosis. Comorbid conditions at baseline were identified using previously defined Elixhauser algorithms, which consider 32 specific conditions.[23]

Outcomes

The primary outcome was women having had at least 1 "diagnostic" or "screening" mammography claim (Current Procedural Terminology [CPT] code 77055, 77056, 77057, 76090, 76091, or 76092; or Healthcare Common Procedure Coding System [HCPCS]

Table 1. Patient Characteristics During First Follow-Up Year (N=27,212)

	Mammogram Only (N=21,247)	Mammogram and MRI (N=2,180)	MRI Only (N=248)	No Imaging (N=3,537)	Total (N=27,212)
Age					
Mean (SD)	61.4 (11.8)	53.7 (9.9)	51.3 (10.4)	61.8 (13.9)	60.7 (12.1)
Median (IQR)	61.0 (52.0–71.0)	53.0 (47.0–60.0)	51.0 (45.0–57.5)	61.0 (51.0–74.0)	60.0 (51.0–70.0)
Age category, y					
<50	3,737 (17.6%)	795 (36.5%)	113 (45.6%)	774 (21.9%)	5,419 (19.9%)
50–64	9,042 (42.6%)	1,082 (49.6%)	108 (43.5%)	1,276 (36.1%)	11,508 (42.3%)
≥65	8,468 (39.9%)	303 (13.9%)	27 (10.9%)	1,487 (42.0%)	10,285 (37.8%)
Race/Ethnicity					
Asian	542 (2.6%)	80 (3.7%)	12 (4.8%)	116 (3.3%)	750 (2.8%)
Black	2,538 (11.9%)	173 (7.9%)	26 (10.5%)	576 (16.3%)	3,313 (12.2%)
Hispanic	1,275 (6.0%)	136 (6.2%)	19 (7.7%)	223 (6.3%)	1,653 (6.1%)
Unknown	991 (4.7%)	103 (4.7%)	17 (6.9%)	184 (5.2%)	1,295 (4.8%)
White	15,901 (74.8%)	1,688 (77.4%)	174 (70.2%)	2,438 (68.9%)	20,201 (74.2%)
Census region					
Midwest	7,000 (33.0%)	497 (22.8%)	46 (18.5%)	1,108 (31.3%)	8,651 (31.8%)
Northeast	2,614 (12.3%)	422 (19.4%)	40 (16.1%)	383 (10.8%)	3,459 (12.7%)
South	8,985 (42.3%)	912 (41.8%)	106 (42.7%)	1,578 (44.6%)	11,581 (42.6%)
West	2,639 (12.4%)	349 (16.0%)	56 (22.6%)	466 (13.2%)	3,510 (12.9%)
Elixhauser comorbidity count					
Mean (SD)	1.7 (1.8)	1.1 (1.4)	1.1 (1.5)	1.9 (2.1)	1.7 (1.8)
Elixhauser category					
0	6,494 (30.6%)	931 (42.7%)	115 (46.4%)	1,114 (31.5%)	8,654 (31.8%)
1–2	9,445 (44.5%)	939 (43.1%)	98 (39.5%)	1,386 (39.2%)	11,868 (43.6%)
≥3	5,308 (25.0%)	310 (14.2%)	35 (14.1%)	1,037 (29.3%)	6,690 (24.6%)
Follow-up, days					
Mean (SD)	1,284.2 (778.7)	1,394.8 (839.2)	1,342.9 (838.5)	1,216.2 (751.3)	1,284.8 (781.8)
Median (IQR)	1,064 (674.0–1,679.0)	1,161 (722.5–1,866.0)	1,148 (689.0–1,783.5)	1,001 (636.0–1,568.0)	1,060 (673.0–1,679.0)
Treatment					
Mastectomy/Radiation	1,305 (6.1%)	118 (5.4%)	21 (8.5%)	431 (12.2%)	1,875 (6.9%)
Mastectomy/No radiation	3,684 (17.3%)	245 (11.2%)	59 (23.8%)	1,482 (41.9%)	5,470 (20.1%)
Lumpectomy/Radiation	14,082 (66.3%)	1,504 (69.0%)	115 (46.4%)	1,030 (29.1%)	16,731 (61.5%)
Lumpectomy/No radiation	2,176 (10.2%)	313 (14.4%)	53 (21.4%)	594 (16.8%)	3,136 (11.5%)
MRI baseline	8,597 (40.5%)	1,389 (63.7%)	147 (59.3%)	1,185 (33.5%)	11,318 (41.6%)
Chemotherapy	5,763 (27.1%)	653 (30.0%)	87 (35.1%)	1,270 (35.9%)	7,773 (28.6%)
Office visit (13 months after surgery)					
≥1 Primary care visit	17,914 (84.3%)	1,968 (90.3%)	205 (82.7%)	2,641 (74.7%)	22,728 (83.5%)
≥1 Oncology visit	10,475 (49.3%)	973 (44.6%)	103 (41.5%)	1,594 (45.1%)	13,145 (48.3%)

code G0202, G0204, or G0206) during a 13-month enrollment span after surgery for breast cancer. We used 13 months to define each year of follow-up out of recognition that it is not always possible to schedule annual tests exactly 12 months apart. For women with ≥13 months of continuous enrollment after their breast surgery, we looked for a mammogram in each sequential 13-month period up to 10 years. Secondary outcomes included the presence of at least one breast MRI (CPT code 76093, 76094, 77058, or 77059; or HCPCS code C8903–C8908) during each 13-month span. For women with >13 months of continuous enrollment after breast surgery, follow-up was censored at time of loss of insurance coverage, metastatic breast cancer diagnosis (defined by ICD-10 code C79.X, or ICD-9 code 197.0–197.3, 197.4–197.6, 197.7, 197.8, 198.0–198.2, 198.3, 198.4, 198.5, 198.6–198.7, 198.82, 198.89, 199.0), or surgical removal of residual breast tissue. Only patients who were not censored before or during each 13-month period were included in the rate calculations for that period. In a secondary analysis, we calculated the mean, SD, median, and interquartile range (IQR) for the number of mammograms per person per year of follow-up.

Statistical Analysis

We described the baseline characteristics of the cohort by imaging type (mammogram alone, mammogram and MRI, MRI alone, or no breast imaging)

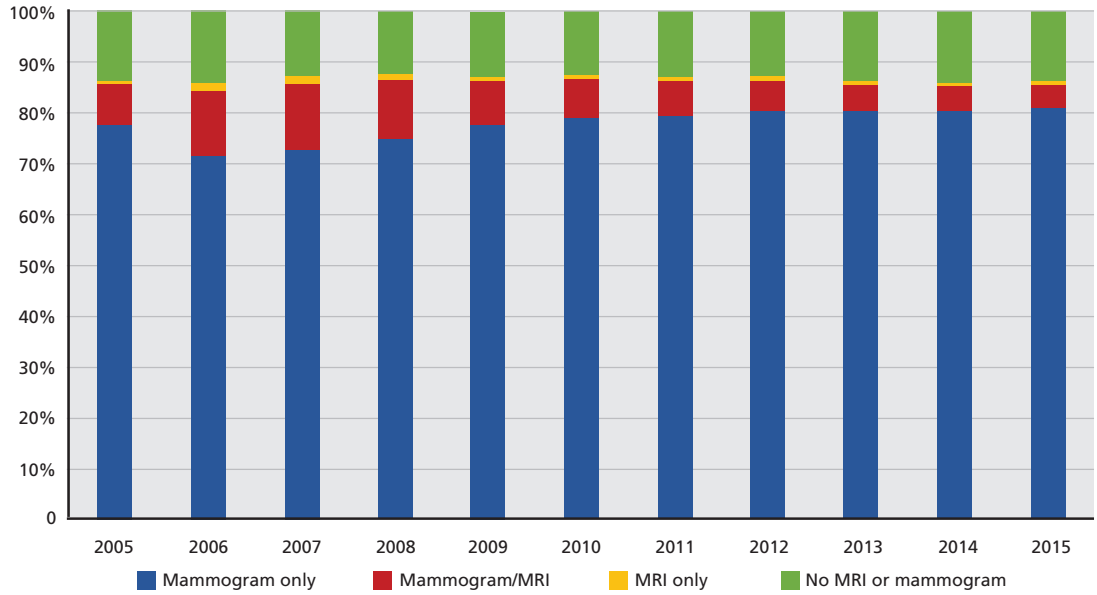

Figure 1. Percentage of patients who had each type of breast imaging by year of breast cancer surgery during their initial 13-month follow-up period.

during the first 13-month period of follow-up after surgery. Characteristics were presented descriptively. We calculated the percentage of women who had at least one mammogram and/or MRI during each subsequent 13-month period of follow-up. We assessed the proportion who received each of the 4 imaging types during the first 13-month follow-up period for each year of breast surgery from January 2005–May 2015.

We estimated multinomial logistic regression models for the first year imaging tests for everyone and for the fifth year imaging tests for those who were continuously covered for at least 65 months after breast surgery (n=4,790). Via this method, we were able to evaluate each surveillance modality (mammogram, mammogram and MRI, and MRI only) compared with no surveillance. SAS 9.3 (SAS Institute Inc.) was used for all statistical analyses.

Results

The cohort included 27,212 women followed for a median of 2.9 years (IQR, 1.8–4.6). Patient characteristics are displayed in Table 1. We found that the proportion of women excluded from this cohort due to bilateral mastectomies within 18 months after diagnosis increased from 25.9% in 2005 to 48.9% in 2014. A total of 4,790 patients remained part of the cohort through at least 65 months of follow-up.

Mammography

After surgery from 2005–2015, mammography rates during the first year of follow-up remained relatively stable (Figure 1). Over the entire study period, 86% of women underwent mammography during year 1, 87% during year 2, 85% during year 3, 83% during year 4, and 80% during year 5 after the definitive breast surgery (Figure 2). Predictors of mammography use are shown in Table 2. The average number of mammograms per person per year was 1.04 (SD, 0.51), and the median was 1.00 (IQR, 0.75–1.35).

MRI

Over the years, the percentage of patients who underwent MRI in the first year after diagnosis decreased from 8% of those diagnosed in 2005 to 5% of those diagnosed in 2015, with a peak at 15% in 2007 (Figure 1). Over the entire study period, in the first year of follow-up, 2,428 (9%) underwent MRI; this proportion was 10% in year 2, 9% in year 3, 8% in year 4, and 7% in year 5 (Figure 2). Predictors of MRI use during the first year are shown in Table 2.

Longitudinal Surveillance After Treatment

Among the 4,790 patients who had complete follow-up for 5 years postsurgery, 50.2% had a mammogram all 5 years, 1.3% had both a mammogram and an MRI

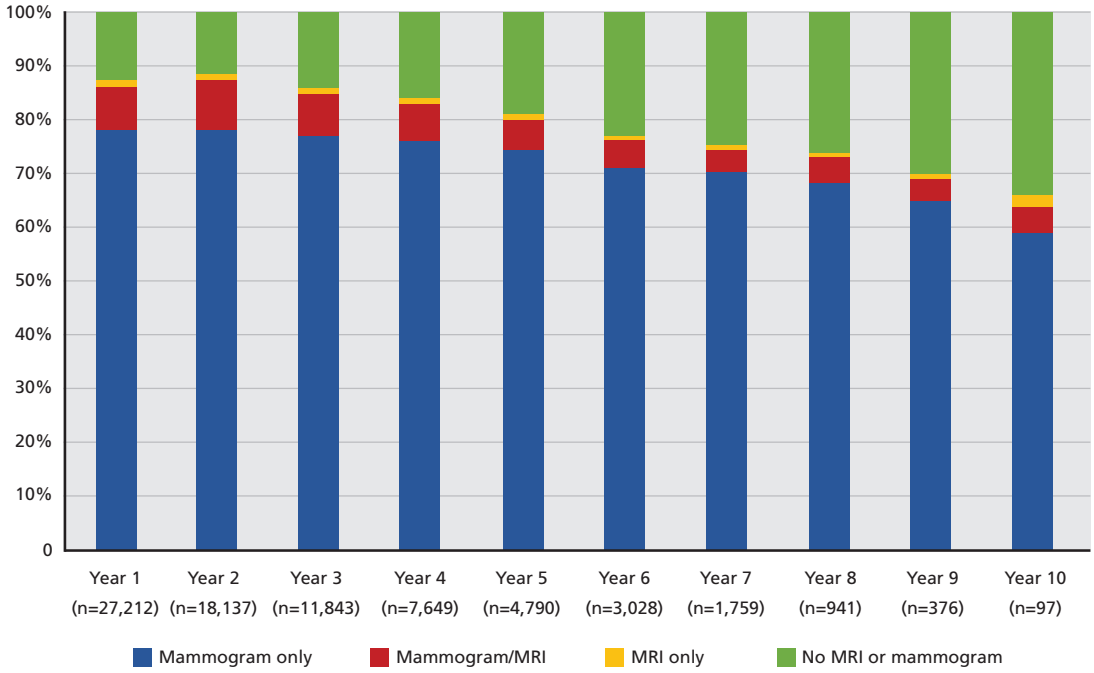

Figure 2. Percentage of patients who had each type of breast imaging by year of follow-up after initial breast cancer surgery.

all 5 years, 3.4% had no mammogram or MRI all 5 years, and the remaining 45.6% switched between different types of surveillance (or no surveillance) in different years. No women received a MRI only during all 5 years of follow-up. Predictors of breast imaging during the fifth year are shown in Table 3.

Discussion

Summary of Findings

Approximately 6 of every 7 breast cancer survivors underwent a mammogram in their first year of follow-up, regardless of their year of initial surgical treatment. This is higher than the <60% rate of annual mammography reported in women aged 50 to 64 years who had not previously been diagnosed with breast cancer.[24] However, as women became long-term survivors, they were less likely to undergo mammography, even in the absence of any change in insurance status, and even in this relatively young cohort. This finding confirms and expands on previous studies showing a significant decline in mammography rates in the fourth or fifth year after treatment.[12,13,15–17,25–27] Our study is novel because it assessed MRI use both in combination with mammography and as a standalone breast surveillance strategy. Given the paucity of data to support breast MRI use in cancer survivors without deleterious *BRCA* mutations,[8,9] it is not surprising that most women with residual breast tissue in the OptumLabs database did not undergo annual MRIs to screen for local recurrences or new primary cancers.

Factors Associated With Surveillance Mammography

Determinants of mammography underuse in this population are poorly understood to date. Among 1,304 Italian patients with breast cancer, 80% had a mammogram and/or clinical breast examination during the first year after treatment, but this decreased to 67% at 10 years of follow-up.[28] Like us, those investigators identified that patients who had undergone mastectomy and had more comorbidities were more likely to not undergo surveillance mammography. Unlike us, they found that older age was associated with a lower likelihood of mammography. This may reflect national differences in healthcare policies and patterns. We were unable to assess whether poorer finances and longer travel time to the hospital (which were significant predictors the Italian study) were also associated with lower odds of having mammography in the United States. The Italian study did not evaluate the rel-

Table 2. Adjusted[a] ORs Compared With No Screening in the First Year of Follow-Up

	Mammography		Mammography/MRI		MRI Only	
Characteristic	**OR[b]**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Age at diagnosis, y						
<50	Ref[c]		Ref		Ref	
50–64	**1.313**	**1.183–1.457**	**0.831**	**0.723–0.953**	**0.63**	**0.471–0.842**
≥65	**1.339**	**1.190–1.507**	**0.336**	**0.279–0.404**	**0.193**	**0.12–0.313**
Race/Ethnicity						
White	Ref		Ref		Ref	
Asian	0.816	0.656–1.015	0.851	0.624–1.16	1.01	0.539–1.893
Black	**0.784**	**0.703–0.874**	**0.545**	**0.45–0.661**	0.728	0.47–1.128
Hispanic	0.964	0.824–1.128	0.806	0.638–1.019	0.971	0.588–1.602
Unknown	**0.821**	**0.692–0.974**	**0.767**	**0.591–0.996**	1.242	0.733–2.102
Census region						
Midwest	Ref		Ref		Ref	
Northeast	1.105	0.968–1.262	**2.123**	**1.761–2.56**	**1.98**	**1.258–3.117**
South	0.914	0.835–1.001	1.104	0.957–1.274	1.316	0.914–1.896
West	**0.818**	**0.721–0.928**	1.092	0.907–1.315	**1.875**	**1.236–2.844**
Elixhauser category						
0	Ref		Ref		Ref	
1–2	**1.100**	**1.003–1.208**	1.074	0.942–1.223	1.013	0.756–1.357
≥3	**0.891**	**0.799–0.992**	**0.743**	**0.624–0.884**	0.796	0.523–1.212
Treatment						
Mastectomy[d]	Ref		Ref		Ref	
Lumpectomy/Radiation	**4.870**	**4.477–5.298**	**7.214**	**6.257–8.317**	**2.703**	**1.998–3.659**
Lumpectomy/No radiation	**1.406**	**1.255–1.574**	**3.893**	**3.2–4.737**	**2.925**	**1.955–4.376**
MRI baseline						
No	Ref		Ref		Ref	
Yes	**1.397**	**1.285–1.518**	**3.145**	**2.783–3.554**	**2.394**	**1.81–3.167**
Diagnosis year						
2005–2006	Ref		Ref		Ref	
2007–2008	1.033	0.903–1.182	1.036	0.862–1.245	1.318	0.885–1.964
2009–2010	1.031	0.903–1.176	**0.685**	**0.567–0.828**	0.729	0.468–1.136
2011–2012	1.034	0.910–1.176	**0.598**	**0.495–0.722**	0.787	0.511–1.212
2013–2014	0.908	0.799–1.032	**0.494**	**0.408–0.598**	**0.543**	**0.341–0.863**
Chemotherapy						
No	Ref		Ref		Ref	
Yes	**0.645**	**0.592–0.703**	**0.589**	**0.518–0.671**	0.766	0.568–1.032
≥1 PCP office visit (during 13 mo postsurgery)						
No	Ref		Ref		Ref	
Yes	**1.150**	**1.066–1.241**	1.059	0.944–1.188	0.937	0.717–1.225
≥1 ONC office visit (during 13 mo postsurgery)						
No	Ref		Ref		Ref	
Yes	**1.576**	**1.433–1.734**	**2.044**	**1.71–2.444**	1.164	0.8–1.693

Entries with CIs that do not cross 1 are bolded.
Abbreviations: ONC, oncologist; OR, odds ratio; PCP, primary care physician.
[a]Adjusted for all covariates shown in the table.
[b]ORs are determined from multinomial logistic regression.
[c]Reference category is no imaging.
[d]Mastectomy with or without radiation.

evance of receiving care from a PCP with or without an oncologist. Contrary to our results, a recent survey of 298 women in Arizona and Colorado approximately 6 years after diagnosis found no differences in self-reported mammography rates related to provider type.[29] Our findings are more consistent with those of Keating et al[11] and Brawarsky et al,[14] who reported that in survivors of invasive or noninvasive breast cancer diagnosed at age >65 years (using SEER-Medicare data), visits to PCPs and oncologists increased the likelihood of surveillance mammography. In general, similar baseline factors remained predictive of mammograms in the fifth year of follow-up as in the first year of follow-up.

Breast MRI Trends Over Time

Although most MRIs were performed in conjunction with mammographic surveillance, a small minority

Table 3. Adjusted[a] ORs for Screening Methods Compared With No Screening for Women With 5 Years of Continuous Coverage (n=4,790) in the Fifth Year of Follow-Up

	Mammography		Mammography/MRI		MRI Only	
Characteristic	**OR[b]**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Age, y (at year 5)						
<50	Ref[c]		Ref		Ref	
50–64	**1.76**	**1.37–2.27**	1.00	0.69–1.46	**0.65**	**0.33–1.27**
≥65	**1.41**	**1.07–1.85**	0.23	0.13–0.39	**0.07**	**0.02–0.35**
Race/Ethnicity						
White	Ref		Ref		Ref	
Asian	0.98	0.60–1.60	0.69	0.29–1.63	0.45	0.06–3.53
Black	0.85	0.67–1.07	0.86	0.53–1.39	0.55	0.16–1.89
Hispanic	1.09	0.74–1.60	1.14	0.62–2.08	0.67	0.15–2.97
Unknown	0.91	0.61–1.36	0.67	0.29–1.59	0.56	0.07–4.26
Census region						
Midwest	Ref		Ref		Ref	
Northeast	1.26	0.94–1.69	**3.33**	**2.06–5.39**	2.09	0.75–5.82
South	0.93	0.77–1.11	1.27	0.87–1.85	0.95	0.43–2.10
West	0.85	0.64–1.11	1.16	0.70–1.90	0.95	0.35–2.60
Elixhauser category during prior year						
0	Ref		Ref		Ref	
1–2	1.00	0.83–1.21	0.77	0.56–1.06	**0.45**	**0.22–0.94**
≥3	0.87	0.69–1.09	0.60	0.36–1.00	0.52	0.15–1.82
Treatment						
Mastectomy[d]	Ref		Ref		Ref	
Lumpectomy/Radiation	**2.60**	**2.20–3.08**	**2.99**	**2.12–4.22**	1.58	0.80–3.13
Lumpectomy/No radiation	1.05	0.82–1.34	**2.15**	**1.29–3.59**	1.49	0.48–4.66
MRI baseline						
No	Ref		Ref		Ref	
Yes	**1.44**	**1.21–1.70**	**4.26**	**3.11–5.85**	**3.53**	**1.77–7.03**
Chemotherapy						
No	Ref		Ref		Ref	
Yes	**0.82**	**0.67–0.99**	0.76	0.55–1.06	1.29	0.64–2.60
≥1 PCP office visit during prior year						
No	Ref		Ref		Ref	
Yes	1.17	1.00–1.37	1.18	0.88–1.58	1.50	0.80–2.82
≥1 ONC office visit during prior year						
No	Ref		Ref		Ref	
Yes	**2.96**	**2.51–3.50**	**3.79**	**2.70–5.31**	**2.86**	**1.35–6.08**

Entries in bold are statistically significant.
Abbreviations: ONC, oncologist; OR, odds ratio; PCP, primary care physician.
[a]Adjusted for all covariates shown in the table.
[b]Odds ratios are determined from multinomial logistic regression.
[c]Reference category is no imaging.
[d]Mastectomy with or without radiation.

of women did undergo MRIs without mammograms. The use of MRIs in this setting (either with or without mammogram) was greatest from 2006 through 2007 (14.4%–14.5%), and has been slowly decreasing since 2008, to a low of 5.4% in 2015. This may be related to the increasing popularity of bilateral mastectomies. The proportion of women with mastectomies from this cohort due to bilateral mastectomies within 18 months after diagnosis increased from 25.9% in 2005 to 48.9% in 2014, likely rendering more of the women at high risk of second primary cancers (ie, due to a known deleterious *BRCA* mutation, an indication for MRI surveillance of residual breast tissue) as having no need for breast surveillance. Although data are scant, it is likely that breast MRI in addition to mammography is more valuable for patients with deleterious *BRCA* mutations and/or strong family histories of breast cancer. Another cause of the recent decline in MRI rates in survivors may be a concomitant decline in MRI rates at the time of breast cancer diagnosis due to the COMICE randomized controlled trial data (published in 2010, but presented orally in 2008) showing that MRI at the time of breast cancer diagnosis did not reduce re-operation rate.[30] Changing insurance guidelines also may have played a part in the decline of MRI rates.

Further research is needed to explore how variability in reimbursements for imaging tests may impact surveillance testing.

Age and Comorbidity

Younger patients may be more likely to have MRIs and less likely to have mammograms due to their denser breast tissue, which reduces sensitivity of mammography. A recent study showed that adding MRIs to mammograms improved sensitivity but reduced specificity in women <50 years of age after breast-conservation therapy.[31] Going forward, the increasing availability of 3-dimensional mammography may reduce the use of MRIs in this setting. Our finding that ≥3 comorbidities reduced the chance of both mammography and MRI is not surprising given that the benefits of surveillance are likely greatest in women without a substantial competing risk of mortality from another disease. The lower likelihood of breast imaging during the first 13 months after surgery in those who underwent mastectomy and chemotherapy may be related to lasting toxicities that made it more difficult for patients to return for breast surveillance.

Racial Disparities

Our finding that black breast cancer survivors were less likely to undergo surveillance breast mammogram or MRI may be a contributor to the elevated rates of breast cancer mortality that have been identified in black women.[32] Given that locoregional recurrences appear to be one of the major drivers of poor prognosis in black women,[33,34] lack of imaging may be a substantial problem. Reasons for this are unclear, but socioeconomic status, comorbidities, lack of social support, and differences in healthcare beliefs may be relevant. Tammemagi[35] found that comorbidities were present in 86% of black patients with breast cancer and only 65.7% of white patients ($P<.001$) at a large Detroit medical center, and therefore an inability to completely control for comorbidities using claims data may have heightened the racial disparities we identified. In our cohort, all patients were insured, but we were unable to control for socioeconomic status, which could affect access to breast imaging due to both transportation difficulties, particularly in rural areas, and out-of-pocket costs. A deleterious *BRCA* mutation in a survivor who decides not to undergo bilateral mastectomy is a strong indication for breast MRI; thus, it is possible that limited access to genetic testing also contributes to the racial disparities in MRI use seen here. However, genetic testing disparities should not impact mammography rates in this cohort.

Strengths and Weaknesses

Strengths of this study include its large size, regional and racial diversity, mixed-age population, and novel and important focus. Limitations include its claims-based methodology, precluding a full understanding of patient and tumor factors that may impact imaging choices. For example, reasons for greater MRI use in certain regions are unknown and will require further study. Because coding for "diagnostic" versus "screening" imaging is not always accurate, we are also unable to clearly discern how imaging rates may have been impacted by the Affordable Care Act mandate that screening, but not diagnostic mammograms, be fully covered. Additionally, our study may have been underpowered to detect certain disparities (eg, between Hispanic vs white patients). Our inability to include uninsured women prevents generalization to the entire US population. Moreover, changes over >3 years could only be assessed in the minority. In addition, we were unable to discern which of the mammograms/MRIs were performed as part of a routine surveillance strategy versus in response to a symptom, an abnormality detected during examination, or a finding on another imaging test (ie, some MRIs may have been used to workup an abnormality detected on a routine mammogram). During the first year, some imaging tests may have been performed postoperatively to assess for residual abnormalities rather than as surveillance for new abnormalities. Furthermore, some MRIs may have been performed due to a known deleterious *BRCA* mutation.

Implications for Healthcare Professionals and Patients

Use of MRI-based surveillance (which is not indicated for most survivors) is relatively rare, particularly in recent years. However, it is concerning that even in an insured cohort, many breast cancer survivors do not undergo their annual recommended surveillance mammography, especially as more time passes after breast cancer diagnosis. This may reflect that the data supporting annual surveillance mammography (rather than mammography every 18–24

months, for example) are sparse, perhaps leading some clinicians to recommend less frequent imaging for patient convenience.[36] Still, our finding will be important for healthcare professionals who wish to encourage annual mammography in this setting. It implies that certain patients may need additional supports and encouragement to adhere to national guidelines. Universal implementation of survivorship care plans that include clear follow-up recommendations may be helpful.

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