UCLA

UCLA Previously Published Works

Title
Use of imaging and biomarker tests for posttreatment care of early-stage breast cancer survivors

Authors

Hahn, Erin E
Hays, Ron D
Kahn, Katherine L
et al.

Original Article

Use of Imaging and Biomarker Tests for Posttreatment Care of Early-Stage Breast Cancer Survivors

Erin E. Hahn, PhD, MPH[1,2]; Ron D. Hays, PhD[3,4]; Katherine L. Kahn, MD[3,4];
Mark S. Litwin, MD, MPH[5]; and Patricia A. Ganz, MD[1,2,6]

BACKGROUND: The American Society of Clinical Oncology (ASCO) recently released a "Top Five" list of opportunities to improve the quality of cancer care. Item 4 on the list advises against using advanced imaging and biomarkers for surveillance in patients with breast cancer who are treated with curative intent. This study examined concordance with ASCO follow-up care guidelines for breast cancer survivors treated at an academic medical center. **METHODS:** Claims data and medical records were reviewed and abstracted for early stage breast cancer survivors starting 1 year post diagnosis. A trained abstractor classified imaging tests as diagnostic or surveillance. Proportions and frequencies were generated for receipt of services. Multilevel logistic regression was used to estimate factors associated with receiving recommended and nonrecommended services and biomarker tests. **RESULTS:** Records were available for 258 patients. Mean age at diagnosis was 58 years (standard deviation of 13 years), mean time since diagnosis was 6 years (standard deviation of 2 years), and 71% were stage 0/1. Only 47% of the sample received a mammogram within 1 year of diagnosis, and 55% of the sample received at least 1 nonrecommended imaging service for surveillance purposes. Seventy-seven percent of the sample received at least 1 nonrecommended biomarker test. Regression results indicate that main treating physician, advanced disease stage, younger age at diagnosis, and greater number of years since diagnosis were associated with receiving nonrecommended services for surveillance. **CONCLUSIONS:** Use of nonrecommended services for surveillance occurs frequently among early-stage breast cancer survivors. There are opportunities to increase use of guideline concordant posttreatment care for breast cancer survivors. *Cancer* 2013;000:000-000. © *2013 American Cancer Society.*

KEYWORDS: breast cancer, posttreatment care, guideline adherence, surveillance, health services.

INTRODUCTION

There are approximately 3 million breast cancer survivors in the United States.[1] Mortality from breast cancer continues to decline due to improvements in screening and treatment, and the majority of patients with breast cancer are diagnosed with early-stage disease and can expect to have extended disease-free survival.[2] Having survived their disease, most patients enter into a prolonged posttreatment phase of care, where the value of active surveillance testing for cancer recurrence has a limited evidence base. Specifically, 2 large Italian randomized trials of breast cancer posttreatment surveillance strategies were conducted during the 1990s, and their results concluded that there was no significant difference in overall survival, time to detection of recurrence, and quality of life perception between the high-intensity and control group monitoring.[3-5] These studies were followed by 2 Cochrane systematic reviews that confirmed a lack of evidence for intensive surveillance for recurrence in this setting.[6,7] These findings prompted the American Society of Clinical Oncology (ASCO) to issue serial guidelines and updates on this topic, with the first in 1996 with the most recent update in 2012.[8-11]

Current evidence-based guidelines for posttreatment surveillance care of patients with breast cancer, from ASCO[11] and the National Comprehensive Cancer Network (NCCN),[12] include explicit recommendations for posttreatment care as well as nonrecommended surveillance services, such as use of advanced imaging services and biomarker tests. Both ASCO and NCCN guidelines recommend annual mammography and a recommended schedule of physician visits that include medical history and physical examination: ASCO recommends a visit every 3 to 6 months for the first 3 years, then every 6 to 12 months for years 4 and 5, and NCCN recommends a visit every 4 to 6 months for 5 years and then

Corresponding author: Erin E. Hahn, PhD, MPH, Division of Cancer Prevention and Control Research, UCLA Jonsson Comprehensive Cancer Center, Room A2-125 CHS, 650 Charles E. Young Drive South, Los Angeles, CA 90095-6900; Fax: (310) 206-3566; eehahn@ucla.edu

[1]University of California Los Angeles (UCLA) Fielding School of Public Health, Department of Health Policy and Management, University of California, Los Angeles, California; [2]Division of Cancer Prevention and Control Research Jonsson Comprehensive Cancer Center, University of California, Los Angeles, California; [3]Department of Medicine, Division of General Internal Medicine and Health Services Research, David Geffen School of Medicine, University of California, Los Angeles, California; [4]RAND Corporation, Santa Monica, California; [5]Department of Urology, David Geffen School of Medicine, University of California, Los Angeles, California; [6]Department of Medicine (Hematology-Oncology), David Geffen School of Medicine, University of California, Los Angeles, California

annually thereafter. Importantly, both guidelines specify that routine surveillance testing with imaging and/or blood tests are not indicated and should only be considered if symptoms arise. Despite these guidelines, the literature reflects a reliance on biomarker tests and advanced imaging for surveillance of breast cancer survivors, with increasing use of imaging services over time.[13-17] To emphasize the importance of its breast cancer surveillance guideline, ASCO included the guideline recommendations in the recently released "Top Five" list as part of the American Board of Internal Medicine's Choosing Wisely campaign.[18] The latter aims to promote evidence-based clinical care that has beneficial effects on patient health by improving treatment and/or reducing risks, and, where possible, reduces costs of care.[19] The ASCO Top Five list advises against routine recurrence surveillance testing in early-stage breast cancer survivors who have completed curative treatment, and discourages use of advanced imaging tests, such as positron emission tomography (PET), computed tomography (CT), and radionuclide bone scans, and biomarker tests, such as carcinoembryonic antigen (CEA) and cancer antigen (CA) 15-3, CA27.29, and CA125).[18] These are low value tests, given the lack of evidence available for benefit. In addition, it is important not to expose breast cancer survivors to unnecessary services that can cause significant harms: exposure to radiation from imaging services, such as CT tests,[20] false positive results that can lead to further, more invasive testing,[21] and increased patient anxiety.[21]

The purpose of this study was to estimate the proportion of posttreatment breast cancer survivors receiving ASCO-recommended and nonrecommended surveillance procedures in a sample of patients treated and followed at an academic medical center. We sought to determine how frequently posttreatment breast cancer patients received biomarker tests and imaging studies, and whether the latter were ordered for diagnostic or surveillance purposes. We also identified whether patients received mammographic surveillance as recommended by ASCO guidelines, because other studies have indicated poor adherence to this recommendation.

MATERIALS AND METHODS

Identification of Sample

Breast cancer survivors were identified within an academic medical center using an administrative data algorithm based on Current Procedural Terminology (CPT) and International Classification of Diseases (ICD) codes. The algorithm was applied to administrative claims data for the interval between 2001 and 2009. This time interval was chosen to allow for sufficient follow-up time after diagnosis and treatment for examination of posttreatment surveillance care. This study received institutional review board approval for all activities (UCLA Institutional Review Board #10-000279).

Eligibility

All patients met the following eligibility criteria: female nonmetastatic (stage 0-IIIA) breast cancer diagnosed between January 1, 2001, and June 30, 2009; 21 years of age and older at the time of diagnosis; no evidence of cancer recurrence or new primary cancer (any type) within the surveillance time frame, and no evidence of previous cancers; and at least 2 years of administrative and medical records in order to assess use of posttreatment services.

Data Sources

We obtained data from administrative claims and medical record abstraction. Variables obtained from administrative data included insurance type, date of birth, breast cancer diagnosis date, and imaging service and biomarker test occurrences by date of test. Variables obtained from medical record data included stage of disease, treatments received, and main treating physician, either a medical oncologist or breast surgeon. A research assistant was trained to perform the medical record abstractions. The training and abstractions were overseen by the study principal investigator and a research nurse practitioner. We captured imaging service and biomarker test data for this protocol starting 1 year after the date of diagnosis to avoid capturing services performed as part of the diagnostic workup or possibly related to treatment complications during active treatment. There was an average of 5 years of surveillance data available per patient (range, 2-10 years).

Variables

The dependent variables were receipt of services: mammograms, imaging (chest and abdominal CT, chest and abdominal magnetic resonance imaging [MRI], abdominal ultrasound, chest x-ray, radionuclide bone scan, PET scan), and biomarker tests (CEA, CA27.29, CA125, CA15-3). Independent variables were age at diagnosis, time since diagnosis (years from date of diagnosis to November 1, 2011), cancer stage (stage 0/1 or stage 2/3A), treatment type (mastectomy/lumpectomy, chemotherapy, radiation), insurance type (health maintenance organization [HMO], preferred provider organization [PPO], Medicare fee-for-service), and main treating physician

(assigned a unique identification number). Twenty-two main treating physicians were identified. For patients treated with surgery only, the breast surgeon was considered the main treating physician. For all other patients, the medical oncologist with the majority of patient visits was considered the main treating physician. The medical oncologist was classified as the main treating physician for 90% of the sample. Insurance type was assigned based on the insurer covering the majority of services and visits during the surveillance timeframe, based on the charges billed to the patient's insurance company. Patients enrolled in Medicare Advantage plans were categorized with the HMO group.

Diagnostic Versus Surveillance Status Determination for Imaging Tests

We coded diagnostic versus surveillance use of posttreatment imaging services by medical record abstraction and review. We reviewed the entire medical record available from the academic medical center. Based on the strategy developed by Cooper et al,[22] the abstractor categorized imaging services into 3 categories: 1) surveillance in the absence of signs or symptoms suggestive of recurrence; 2) diagnostic with signs or symptoms suggestive of recurrence, metastatic disease, or other disease or problem; or 3) indeterminate with no associated physician note. Categorization was based on the physician note associated with the service and the associated ICD codes used for health insurance billing. Physician notes that contained an active statement describing routine follow-up care with an imaging service were categorized as surveillance. The lack of a definitive statement of a new symptom or problem was also considered reason to categorize an imaging service as surveillance. However, it is possible that some of the imaging services classified as surveillance were, in fact, ordered for a diagnostic reason that was not recorded in the medical record or reflected in the associated ICD code. This categorization strategy may have resulted in overestimation of surveillance imaging services. Services with associated notes describing a new symptom or problem were categorized as diagnostic. The 4% of services initially categorized as indeterminate due to missing physician notes were reviewed during group meetings that included the research assistant, research nurse practitioner, and the principal investigator. After discussion and review, consensus was reached on categorization of diagnostic or surveillance for the services initially categorized as indeterminate. The majority of indeterminate services were categorized as surveillance based on an associated ICD code indicating breast cancer (eg, 174.xx). Our categorization approach was conservative: imaging services initially classified as diagnostic remained so throughout the surveillance time frame, even though the subsequent follow-up could have been surveillance. A random sample of 15% of the records was also abstracted by the research nurse practitioner as a second coder comparison. A kappa statistic comparing the classification of surveillance versus diagnostic was calculated to measure agreement between the 2 sets of abstractions, yielding a $k = 0.72$ ("substantial" agreement).[23]

Data Analysis

All analyses were performed using Stata software, version 12.0. Means, ranges, and percentages were generated to summarize patient demographics and cancer disease and treatment characteristics. Proportions and frequencies were generated for receipt of ASCO guideline recommended and nonrecommended services. Time to receipt of first mammogram for eligible patients was estimated using Kaplan-Meier estimates. Use of surveillance versus diagnostic imaging services was examined with proportions. Multilevel logistic regression with a random effect for main treating physician was used to estimate the unique association of independent variables with receiving recommended and nonrecommended imaging services and biomarker tests. A multilevel model was used in order to account for the clustering of patients within the main treating physician variable.

RESULTS

Study Sample

The study sample included 258 survivors after excluding 126. The most common reason for exclusion was less than 2 years of surveillance time at the academic medical center. Many patients were initially treated at the center, but then switched their care to a provider outside the academic health system. The mean age of the sample was 58 years (standard deviation [SD] = 13) and the mean time since diagnosis was 6 years (SD = 2) (Table 1). The majority of patients had stage 0/1 disease and were treated with lumpectomy and radiation, and 59% were enrolled in an HMO insurance plan. Three physicians were identified as the main treating physician for more than half of the sample.

Use of Imaging and Biomarker Tests

Overall, 83% of the sample received at least 1 mammogram during the posttreatment period of observation. The length of time to the first mammogram for all eligible patients after cessation of active treatment (assumed to be

TABLE 1. Patient Demographics and Cancer Disease and Treatment Characteristics (N = 258)

Characteristic	Number	%
Age at diagnosis, y		
Mean (standard deviation)	58 (13)	
Range	[28, 95]	
Years from diagnosis date to November 1, 2011		
Mean (standard deviation)	6 (2)	
Range	[2, 10]	
Disease stage		
Stage 0 or 1	182	71
Stage 2 or 3A	76	30
Lumpectomy		
Yes	187	72
No	71	28
Mastectomy		
Yes	71	28
No	187	72
Chemotherapy		
Yes	104	40
No	154	60
Radiation		
Yes	188	73
No	70	27
Insurance type		
HMO	151	59
PPO	37	14
Medicare	70	27
Main treating physician		
Provider 1	24	9
Provider 2	67	26
Provider 4	39	15
Provider 5	25	10
Provider 6	6	2
Provider 7	34	13
Provider 8	7	3
Provider 9	9	4
Provider 10	5	2
Provider 11	5	2
Provider 13	17	7
Other[a]	20	8

[a] Other includes providers with fewer than 3 patients.
Abbreviations: HMO, health maintenance organization; PPO, preferred provider organization.

Figure 1. Kaplan-Meier estimate of time to first mammogram is shown for eligible patients (N = 239).

TABLE 2. Number of Mammograms Received by Years After Cessation of Active Treatment

Time Interval: Years After Treatment Cessation	Patients in Interval	Patients Who Received a Mammogram (% of Total Sample in Interval)
1	258	120 (47%)
2	243	115 (47%)
3	217	127 (59%)
4	174	105 (60%)
5	121	55 (46%)

12 months after the date of diagnosis) is shown in Figure 1. Those with bilateral mastectomy were excluded (n = 19). Forty-seven percent of the sample received the first mammogram within a year of cessation of active treatment, and 67% of the sample received the first mammogram within 2 years. Of the 120 patients who had a first mammogram within 1 year of cessation of active treatment, 56 (47%) had a second mammogram within the next year (Table 2). We explored whether insurance status influenced the percentage receiving a follow-up mammogram within the first year after treatment: 52% of HMO-insured patients received a mammogram within the first year versus 40% of those with PPO or Medicare insurance (P = .05, data not shown).

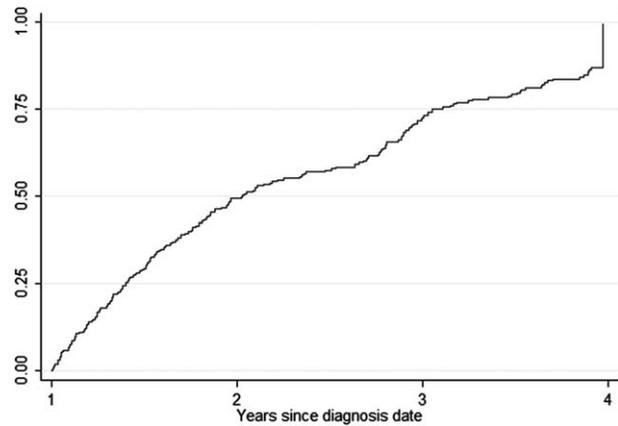Sixty-seven percent of the sample received at least 1 nonrecommended imaging service. The most common nonrecommended imaging service was chest x-ray, with 45% of the sample receiving at least 1 (Table 3); 30% of the sample received at least 1 breast MRI, and 20% received at least 1 chest CT. Eighty percent of the sample received at least 1 nonrecommended biomarker test. Seventy-seven percent of the sample received at least 1 CEA test, and 77% of the sample received at least 1 CA27.29. The majority of CEA and CA27.29 tests were performed within the first 2 years after cessation of active treatment (Fig. 2). Sixteen percent of all CEA and CA27.29 tests were performed 5 or more years after active treatment ended. CA125 and CA15-3 tests were used less commonly, with 18% and 5% receiving at least 1 of each test, respectively.

Surveillance Versus Diagnostic Use of Imaging Services

Fifty-five percent of the sample received at least 1 nonrecommended imaging service that was classified as surveillance. Four imaging services were classified as surveillance the majority of the time: 79 abdominal CTs (61%), 128

breast MRIs (82%), 79 chest CTs (57%), and 72 PET scans (93%) (Table 3). Only 28% of chest x-rays, the most commonly used imaging service, were classified as surveillance. The majority of abdominal MRI, abdominal ultrasound, and bone scans were classified as diagnostic. Out of all nonrecommended imaging services captured, 48% (514 of 1082) were classified as surveillance.

Variables Associated With Receiving Imaging Services and Biomarker Tests

Stage of disease, age at diagnosis, and years since diagnosis were significantly associated with receiving a nonrecommended imaging service that was classified as surveillance (Table 4). The odds of receiving a nonrecommended imaging service classified as surveillance were 2.70 times

Figure 2. Histogram shows number of years since diagnosis date that carcinoembryonic antigen (CEA) and cancer antigen (CA) 27.29 tests occurred (N = 258).

higher for those who had stage 2 or stage 3A disease than for those who had stage 0 or stage 1 disease ($P = .01$). Younger age at diagnosis was associated with higher odds of receiving a nonrecommended imaging service classified as surveillance, with a 1-year increase in age at diagnosis associated with a 3% decrease in the odds of receiving a nonrecommended imaging service classified as surveillance (OR = 0.97, $P = .05$). A 1-year increase in years since diagnosis was associated with a 23% increase in the odds of receiving a nonrecommended imaging service classified as surveillance (odds ratio [OR] = 1.23, $P = .02$). Main treating physician was also important in explaining variation in receipt of nonrecommended imaging services. The intraclass correlation (rho) for main treating physician was 0.19 and significantly different than zero, meaning that 19% of the variance in receiving a nonrecommended imaging service classified as surveillance was accounted for by the main treating physician.

Radiation, age at diagnosis, and insurance type were all significantly associated with receiving a mammogram. The odds of receiving a mammogram were 1.98 times higher for those who received radiation than for those who did not ($P = .08$), and the odds of receiving a mammogram for those with Medicare fee-for-service insurance were 8.99 times higher than those with HMO insurance ($P < .001$). A 1-year increase in age at diagnosis resulted in a 6% decrease in the odds of receiving a mammogram (OR = 0.94, $P = .001$). Main treating physician was also important in explaining variation in receipt of mammograms. The intraclass correlation was 0.22 and significantly different than zero, meaning that 22% of the variance in receiving a mammogram was accounted for by the main treating physician.
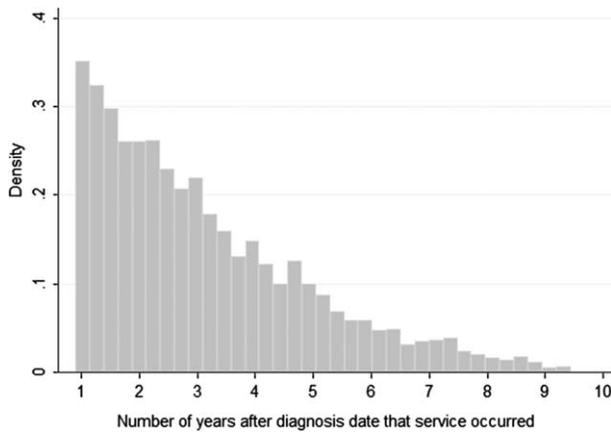
TABLE 3. Use of Nonrecommended Imaging Services and Biomarker Tests Starting 1 Year After Diagnosis Including Percent of Imaging Services Used for Surveillance (N = 258)

Imaging Service or Biomarker Test	Percent of Sample Who Received at Least One (No.)	Total Service Count	Percent Surveillance Out of Total Service Count (No.)
Abdominal CT	19% (48)	129	61% (79)
Abdominal MRI	4% (11)	21	39% (8)
Abdominal ultrasound	15% (37)	53	13% (7)
Bone scan	17% (44)	64	26% (17)
Breast MRI	30% (77)	156	82% (128)
Chest CT	20% (52)	139	57% (79)
Chest x-ray	45% (114)	443	28% (124)
PET scan	12% (31)	77	93% (72)
CA15-3	5% (14)	30	-
CA125	18% (46)	91	-
CA27.29	77% (199)	1661	-
CEA	77% (198)	1518	-

Abbreviations: CA, cancer antigen; CEA, carcinoembryonic antigen; CT, computed tomography; MRI, magnetic resonance imaging; PET, positron emission tomography.

TABLE 4. Multilevel Logistic Regression With Random Effects for the Main Treating Physician[a]

Model 1: Received any nonrecommended imaging service for surveillance				
Variable	Odds Ratio	Standard Error	P	95% Confidence Interval
Mastectomy	1.97	0.89	.13	[0.81, 4.76]
Radiation	1.77	0.76	.19	[0.76, 4.12]
Chemotherapy	1.34	0.34	.24	[0.82, 2.18]
Stage 2/3A	2.70	1.04	.01	[1.27, 5.74]
Age at diagnosis	0.97	0.02	.05	[0.93, 0.99]
PPO insurance	0.55	0.28	.23	[0.20, 1.48]
Medicare	0.79	0.37	.61	[0.31, 1.97]
Years since diagnosis	1.23	0.11	.02	[1.03, 1.46]
Sigma_u	0.89	0.29		[0.47, 1.68]
Intraclass correlation (rho)[b]	0.19	0.10		[0.06, 0.46]
Likelihood ratio test: rho = 0	chibar2(01) = 17.33 Prob > = chibar2 = 0.000			

Model 2: Received any posttreatment mammogram				
Variable	Odds Ratio	Standard Error	P	95% Confidence Interval
Mastectomy	0.88	0.36	.76	[0.39, 1.97]
Radiation	1.98	0.78	.08	[0.92, 4.30]
Chemotherapy	0.93	0.22	.77	[0.59, 1.48]
Stage 2/3A	1.17	0.46	.69	[0.54, 2.52]
Age at diagnosis	0.94	0.02	.001	[0.91, 0.98]
PPO insurance	1.21	0.59	.70	[0.46, 3.16]
Medicare	8.99	4.82	.000	[3.14, 25.72]
Years since diagnosis	1.06	0.09	.51	[0.89, 1.26]
Sigma_u	0.97	0.36		[0.47, 2.01]
Intraclass correlation (rho)[b]	0.22	0.13		[0.06, 0.56]
Likelihood ratio test: rho = 0	chibar2(01) = 10.18 Prob > = chibar2 = 0.001			

Model 3: Received any nonrecommended biomarker test				
Variable	Odds Ratio	Standard Error	P	95% Confidence Interval
Mastectomy	1.27	0.79	.70	[0.38, 4.28]
Radiation	0.94	0.54	.91	[0.30, 2.93]
Chemotherapy	1.59	0.50	.14	[0.86, 2.93]
Stage 2/3A	4.24	2.93	.04	[1.10, 16.43]
Age at diagnosis	1.02	0.03	.43	[0.97, 1.07]
PPO insurance	1.17	0.78	.82	[0.31, 4.35]
Medicare	0.99	0.67	.99	[0.26, 3.75]
Years since diagnosis	1.42	0.18	.006	[1.11, 1.83]
Sigma_u	2.04	0.59		[1.16, 3.59]
Intraclass correlation (rho)[b]	0.56	0.14		[0.29, 0.80]
Likelihood ratio test: rho = 0	chibar2(01) = 33.11 Prob > = chibar2 = 0.000			

[a] Model 1) received any nonrecommended imaging service determined to be for surveillance purposes (computed tomography scan, magnetic resonance imaging, ultrasound, bone scan, positron emission tomography scan); Model 2) received any posttreatment mammogram; and Model 3) received any nonrecommended biomarker test: carcinoembryonic antigen (CEA), cancer antigen (CA) 15-3, CA27.29, and CA125 tests. The group variable is the main treating physician. N = 258
Reference groups: Lumpectomy, health maintenance organization (HMO) insurance, stage 0/1 disease
[b] The intraclass correlation (rho) is the amount of variance in the outcome accounted for by the group variable, main treating physician.
Abbreviations: PPO: Preferred provider organization

Stage and years since diagnosis were significantly associated with receiving nonrecommended biomarker tests (CEA, CA15-3, CA27.29, and CA125). The odds of receiving a nonrecommended biomarker test for those with stage 2 or stage 3A disease were 4.24 times higher than those with stage 0 or stage 1 disease, ($P = .04$), and a 1-year increase in years since diagnosis was associated with a 42% increase in the odds of receiving a nonrecommended biomarker test ($P = .006$). Main treating physician was also important in explaining variation in receipt

of nonrecommended biomarker tests. The intraclass correlation for main treating physician was 0.56 and significantly different than zero, meaning that 56% of the variance in receiving a nonrecommended biomarker test was accounted for by the main treating physician.

DISCUSSION

We examined use of ASCO-recommended and nonrecommended posttreatment services in a group of breast cancer survivors treated and followed at an academic medical center. Only 47% of the sample received a recommended mammogram in the first year after cessation of active treatment, which falls well short of the ASCO recommendation of 1 mammogram at 1 year after the initial diagnostic mammogram. However, some patients may have received mammograms outside of the academic medical center, leading to an overestimation of the length of time to the first mammogram. HMO-insured patients in the sample had a slightly higher percentage of mammograms by the end of the first year than did patients insured by PPO or Medicare (data not shown), although both groups are well below the ASCO recommendation. However, our overall mammogram findings are similar to other studies. A study using the Surveillance, Epidemiology, and End Results registry linked to Medicare claims (SEER-Medicare) to examine use of annual mammograms in a cohort of breast cancer survivors found that only 62% received annual mammograms.[24] Other studies have reported rates of annual mammograms for breast cancer survivors from 50% to 80%.[16,25-27] We also found that nonrecommended imaging services were used frequently, particularly chest x-ray, with almost half of the sample receiving at least 1 procedure. Nonrecommended biomarker tests were also commonly used, particularly CEA and CA27.29.

Importantly, we were able to categorize the nonrecommended imaging services as surveillance or diagnostic using medical record abstraction. The majority of published studies examining adherence to breast cancer surveillance guidelines used administrative data only.[14,16,28] A 2006 study characterized posttreatment care in cancer survivors as surveillance or diagnostic using medical record abstraction.[22] The results showed that 49% of imaging services for breast cancer survivors were used for surveillance only. In our study, 48% of all imaging services were classified as surveillance. PET scans were almost uniformly classified as surveillance (93%), and breast MRIs (82%) and abdominal CTs (61%) were classified as surveillance the majority of the time. These services were routinely ordered with 55% of

the sample receiving at least 1 nonrecommended imaging test classified as surveillance, despite the evidence showing little to no benefit of aggressive posttreatment surveillance programs.[6,10,29] However, this may be an overestimation of services ordered for surveillance. Our classification scheme assigned imaging services that lacked a definitive statement of a new symptom or problem as surveillance, potentially misclassifying services that were in fact diagnostic. Most imaging services did have an associated note that contained an active statement of surveillance or diagnosis of a new symptom or problem, but some associated notes were vague, leading to uncertainty regarding classification.

The variables associated with receipt of a nonrecommended imaging service for surveillance purposes show that ordering these services is influenced by a diverse set of factors (Table 4). For patients with higher stage disease and younger age at diagnosis, physicians and patients may elect a more aggressive surveillance approach with the hope of identifying recurrent or new disease early, although available evidence does not support this approach. The main treating physician was significant in each of the three models, accounting for 19%, 22%, and 56% of the variance in receiving a nonrecommended imaging service for surveillance, receiving a mammogram, and receiving a nonrecommended biomarker test, respectively. This finding suggests that appropriate feedback to individual physicians about their usage patterns could influence subsequent adherence to guidelines. Patient demand for services may also play a role in these findings.

This study has several limitations. First, this is a relatively small sample of patients treated and followed at a single academic center. This allowed us to do detailed medical record abstractions, providing important data on use of posttreatment services. However, this limits the generalizability of our findings. Other types of institutions may have very different practices and customs for posttreatment follow-up care, although several larger studies have found poor adherence to posttreatment guidelines for cancer patients generally.[13,16,22,30] Second, imaging services initially classified as diagnostic remained so throughout the surveillance timeframe, a conservative approach that potentially underestimates the number of surveillance services. Even using this conservative approach we found a high percentage of imaging services were used for surveillance purposes. Third, we used data solely from one academic medical center and did not seek outside records. Patients may have received care elsewhere, which could have led to underestimation of

appropriate and inappropriate services. Our examination of the sample by insurance group shows that even HMO-insured patients who can be expected to receive all of their care within the academic medical center did not all receive mammograms within the first year after diagnosis, suggesting that underuse of recommended services is a systematic problem. Finally, we had limited patient-level variables. Potentially important demographic variables and patient awareness/desire for posttreatment care were not available from our data sources.

In conclusion, our findings show a high rate of nonrecommended testing and underuse of mammographic screening in early-stage breast cancer survivors treated and followed at an academic medical center. These patterns were observed in a setting where individual physicians do not have a financial incentive for ordering tests and services, and should have access to evidence-based guidelines to direct follow-up care. This suggests that the ordering of nonrecommended services is a complex process driven by multiple factors, only some of which were captured in this study. Overuse of posttreatment services is a persistent problem with potentially serious impacts: false positive results that may lead to use of unnecessary invasive procedures, financial costs, and heightened patient anxiety. As the population of breast cancer survivors continues to grow, it will be of even greater importance to base posttreatment care decisions on available evidence and guidelines.

FUNDING SOURCES

CONFLICT OF INTEREST DISCLOSURE

The authors made no disclosures.

REFERENCES

1. Siegel R, DeSantis C, Virgo K, et al. Cancer treatment and survivorship statistics, 2012. *CA Cancer J Clin.* 2012;62:220-241.
2. American Cancer Society. Cancer Facts & Figures 2012. Atlanta, GA: American Cancer Society; 2012.
3. Rosselli Del Turco M, Palli D, Cariddi A, Ciatto S, Pacini P, Distante V. Intensive diagnostic follow-up after treatment of primary breast cancer. A randomized trial. National Research Council Project on Breast Cancer follow-up. *JAMA.* 1994;271:1593-1597.
4. Liberati A. The GIVIO trial on the impact of follow-up care on survival and quality of life in breast cancer patients: Interdisciplinary Group for Cancer Care Evaluation. *Ann Oncol.* 1995;6(suppl 2):41-46.
5. The GIVIO Investigators. Impact of follow-up testing on survival and health-related quality of life in breast cancer patients. A multicenter randomized controlled trial. *JAMA.* 1994;271:1587-1592.
6. Rojas MP, Telaro E, Russo A, et al. Follow-up strategies for women treated for early breast cancer. *Cochrane Database Syst Rev.* 2000;(4):CD001768.
7. Rojas MP, Telaro E, Russo A, et al. Follow-up strategies for women treated for early breast cancer (update). *Cochrane Database Syst Rev.* 2005;(1):CD001768.
8. American Society of Clinical Oncology. Recommended breast cancer surveillance guidelines. *J Clin Oncol.* 1997;15:2149-2156.
9. Smith TJ, Davidson NE, Schapira DV, et al. American Society of Clinical Oncology 1998 update of recommended breast cancer surveillance guidelines. *J Clin Oncol.* 1999;17:1080-1082.
10. Khatcheressian JL, Wolff AC, Smith TJ, et al;American Society of Clinical Oncology. American Society of Clinical Oncology 2006 update of the breast cancer follow-up and management guidelines in the adjuvant setting. *J Clin Oncol.* 2006;24:5091-5097.
11. Khatcheressian JL, Hurley P, Bantug E, et al;American Society of Clinical Oncology. Breast cancer follow-up and management after primary treatment: American Society of Clinical Oncology clinical practice guideline update. *J Clin Oncol.* 2013;31:961-965.
12. National Comprehensive Cancer Network.NCCN Clinical Practice Guidelines: breast cancer. http://www.nccn.org/professionals/physician_gls/f_guidelines.asp#breast. Accessed July 8, 2013.
13. Lafata J, Simpkins J, Schultz L, et al. Routine surveillance care after cancer treatment with curative intent. *Med Care.* 2005;43:592-599.
14. Keating N, Landrum M, Guadagnoli E, et al. Surveillance testing among survivors of early-stage breast cancer. *J Clin Oncol.* 2010;25:1074-1081.
15. Mandelblatt J, Lawrence W, Cullen J, et al. Patterns of care in early stage breast cancer survivors in the first year after cessation of active treatment. *J Clin Oncol.* 2006;24:77-84.
16. Grunfeld E, Hodgson D, Del Giudice M, et al. Population-based longitudinal study of follow-up care for breast cancer survivors. *J Oncol Pract.* 2010;6:174-181.
17. Dinan MA, Curtis LH, Hammill BG, et al. Changes in the use and costs of diagnostic imaging among Medicare beneficiaries with cancer, 1999-2006. *JAMA.* 2010;303:1625-1631.
18. Schnipper LE, Smith TJ, Raghavan D, et al. American Society of Clinical Oncology identifies five key opportunities to improve care and reduce costs: the top five list for oncology. *J Clin Oncol.* 2012;30:1715-1724.
19. Good Stewardship Working Group. The "top 5" lists in primary care: meeting the responsibility of professionalism. *Arch Intern Med.* 2011;171:1385-1390.
20. Smith-Bindman R, Lipson J, Marcus R, et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. *Arch Intern Med.* 2009;169:2078-2086.
21. Brodersen J, Siersma VD. Long-term psychosocial consequences of false-positive screening mammography. *Ann Fam Med.* 2013;11:106-115.
22. Cooper G, Johnson C, Lamerato L, et al. Use of guideline recommended follow-up care in cancer survivors: routine or diagnostic indications? *Med Care.* 2006;44:590-594.
23. Viera A, Garrett J. Understanding interobserver agreement: the Kappa statistic. *Fam Med.* 2005;37:360-363.
24. Schapira MM, McAuliffe TL, Nattinger AB. Underutilization of mammography in older breast cancer survivors. *Med Care.* 2000;38:281-289.

25. Sabatino SA, Thompson TD, Richardson LC, et al. Health insurance and other factors associated with mammography surveillance among breast cancer survivors: results from a national survey. *Med Care.* 2012;50:270-276.
26. Keating NL, Landrum MB, Guadagnoli E, Winer EP, Ayanian JZ. Factors related to underuse of surveillance mammography among breast cancer survivors. *J Clin Oncol.* 2006;24:85-94.
27. Field TS, Doubeni C, Fox MP, et al. Under utilization of surveillance mammography among older breast cancer survivors. *J Gen Intern Med.* 2008;23:158-163.
28. Panageas K, Sima C, Liberman L, et al. Use of high technology imaging for surveillance of early stage breast cancer. *Breast Cancer Res Treat.* 2012;131:663-670.
29. Pivot X, Asmar L, Hortobagyi GN, Theriault R, Pastorini F, Buzdar A. A retrospective study of first indicators of breast cancer recurrence. *Oncology.* 2000;58:185-190.
30. Keating N, Landrum M, Guadagnoli E, et al. Surveillance testing among survivors of early-stage breast cancer. *J Clin Oncol.* 2007;25:1074-1081.