Use of Imaging for Staging of Early-Stage Breast Cancer in Two Integrated Health Care Systems: Adherence With a Choosing Wisely Recommendation

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Abstract

Purpose: Advanced imaging is commonly used for staging of early-stage breast cancer, despite recommendations against this practice. The objective of this study was to evaluate and compare use of imaging for staging of breast cancer in two integrated health care systems, Kaiser Permanente (KP) and Intermountain Healthcare (IH). We also sought to distinguish whether imaging was routine or used for diagnostic purposes.

Methods: We identified patients with stages 0 to IIB breast cancer diagnosed between 2010 and 2012. Using KP and IH electronic health records, we identified use of computed tomography, positron emission tomography, or bone scintigraphy 30 days before diagnosis to 30 days postsurgery. We performed chart abstraction on a random sample of pa-

tients who received a presurgical imaging test to identify indication.

Results: For the sample of 10,010 patients, mean age at diagnosis was 60 years (range, 22 to 99 years); with 21% stage 0, 47% stage I, and 32% stage II. Overall, 15% of patients ($n = 1,480$) received at least one imaging test during the staging window, 15% at KP and 14% at IH ($P = .5$). Eight percent of patients received imaging before surgery, and 7% postsurgery. We found significant intraregional variation in imaging use. Chart abstraction ($n = 129$, 16% of patients who received presurgical imaging) revealed that 48% of presurgical imaging was diagnostic.

Conclusion: Use of imaging for staging of low-risk breast cancer was similar in both systems, and slightly lower than has been reported in the literature. Approximately half of imaging tests were ordered in response to a sign or symptom.

Introduction

Breast cancer is the most commonly diagnosed cancer in women, accounting for approximately 28% of all new cancer diagnoses, excluding nonmelanoma skin cancers.¹ Approximately 230,000 new cases of invasive breast cancer were expected to be diagnosed in the United States in 2014.¹ An additional 62,000 new cases of in situ breast cancer were estimated to be diagnosed.² The majority of these cases, approximately 60%, will be diagnosed at a localized stage.¹ Use of advanced imaging modalities, including positron emission tomography (PET), computed tomography (CT), and radionuclide bone scans for staging of localized breast cancer is not recommended for asymptomatic women. There is little evidence of benefit (eg, improved detection of metastatic disease or improved survival),³⁻⁵ and use of advanced imaging may expose patients to unnecessary harms.^{6,7} Evidence-based guidelines from the National Comprehensive Cancer Network (NCCN), as well as guidelines from Cancer Care Ontario and the Alberta Health Services clinical guidelines group, include recommendations against use of advanced imaging for staging of early breast cancer.⁸⁻¹⁰ The 2012 ASCO Top Five list includes “Do not perform PET, CT, and radionuclide bone scans in the staging of early breast cancer at low risk for metastasis” as the

third recommendation.⁷ The ASCO Top Five lists,^{7,11} developed as part of the American Board of Internal Medicine Choosing Wisely campaign, emphasize limiting low-value cancer care services.¹² Choosing Wisely is dedicated to reducing the use of low-value health care services throughout the US health care system. It has received considerable attention in the medical and lay press.¹³⁻¹⁵ A recent survey of primary care and specialty physicians found that physicians exposed to the Choosing Wisely campaign were more likely not to recommend an unnecessary test or procedure than physicians not exposed to the campaign (62% *v* 45%).¹⁶

Despite these guideline recommendations, and the recent attention of the Choosing Wisely campaign, it has been shown that use of imaging for staging of early-stage breast cancer is common.¹⁷⁻²⁰ In addition, use of advanced imaging modalities has increased over time, particularly in cancer care.^{21,22} The objective of this study was to measure and compare use of imaging for staging of early-stage breast cancer in two large integrated health care systems, Kaiser Permanente (KP) and Intermountain Healthcare (IH). Studies from established integrated systems are valuable as more health care organizations move toward accountable care and medical home models of care delivery, providing insight into how these models may

influence use of low-value cancer services. We also sought to distinguish whether presurgical imaging was routine or diagnostic (used in response to symptoms or signs).

Methods

This study was conducted in two integrated systems, KP and IH. We compared use of imaging services between the two systems to assess whether variation in care delivery patterns exists between integrated systems with similar, although not identical, organizational structure. We also examined regional use within each system, to assess whether geographic variation exists within each system, or whether the integrated nature of these systems discourages intrasystem variation. We examined use of PET, CT, and bone scan from 30 days before the recorded diagnosis date in the cancer registry to 30 days after the date of surgery (lumpectomy or mastectomy).

Setting

KP is an integrated health care system providing comprehensive health care services to approximately 9 million members. KP operates in eight states and the District of Columbia and is divided into seven regions. For this study, we obtained data from three regions: KP Southern California (KPSC), KP Northwest (KPNW), and KP Mid-Atlantic States (KPMAS). KPSC has the largest membership, with approximately 3.7 million members. Intermountain Healthcare is a regional, not-for-profit integrated health care system in Utah and southern Idaho. It consists of 22 hospitals and nine cancer centers and is divided into four regions: Urban Central Region (UCR), Urban North Region (UNR), Urban South Region (USR), and Southwest Region (SWR). There were approximately one million unique patients with IH hospital visits in 2013, with the largest number in UCR. Patients have a mix of insurance types within these two systems, including commercial insurance, Medicare, and Medicaid. The majority of KP members participate in capitated health plans, whereas IH is a mixture of capitated and fee-for-service plans. KP is structured as a group model health maintenance organization, and KP medical groups contract exclusively with the KP health plans. IH has a variety of relationships with affiliated providers, with a mix of employed and nonemployed physicians. This study received institutional review board (IRB) approval for all activities, and KPSC acted as lead IRB for all KP study activities (KPSC IRB #10145; IH IRB# 1024956).

Identification of Sample

We identified patients using KP and IH tumor registries. We included female patients diagnosed with stages 0 to IIb breast cancer between January 1, 2010, and December 31, 2012, based on American Joint Committee on Cancer (AJCC) Stage criteria, seventh edition. We restricted the sample to patients who received definitive cancer-directed surgery ([Appendix Figure A1](#), online only). We excluded patients with a history of any cancer diagnosis, excluding nonmelanoma skin cancers. Tumor registry data provided information on date of birth, age at di-

agnosis, pathological stage, tumor histology, tumor grade, treatment type(s) (eg, surgical type, chemotherapy, radiation), and treatment dates, with the exception of the KPMAS tumor registry which did not include treatment type.

Data Sources

We used Current Procedural Terminology codes and International Classification of Diseases (ed 9) to identify PET, CT, and radionuclide bone scans, restricting our choice of imaging services to these three imaging types to reflect the recommendations from the ASCO 2012 Top Five list. We excluded imaging services performed in the emergency department or inpatient setting, as services in this setting are unlikely to be related to staging for clinical early-stage breast cancer, and our intent was to assess usual patterns of care in the oncology setting. Chart abstractions were performed on a stratified random sample of charts by image test type in patients who received presurgical imaging. Our goal was to abstract at least 15% of patients who received a nonrecommended imaging service, a target chosen as both feasible and likely to provide useful information. Chart abstractors at each site, including research associates, a registered nurse, and an internal medicine physician, were trained with a centralized chart abstraction protocol developed by the study investigators. The abstractors, with supervision and consultation with the site principal investigators and research team, categorized imaging services as diagnostic (used in response to a clinical sign found on physical exam, prior finding, or patient reported symptom) or routine (used in absence of signs or symptoms indicative of potential metastatic disease), based on categories developed by Cooper et al to categorize surveillance services in cancer care.²³ These categories, although developed to categorize cancer surveillance services, are broadly applicable for capturing clinical indication of services. Categorization of diagnostic or routine was based on the clinician note(s) associated with the imaging service, and documented signs and symptoms were captured in a study database to aid in categorization. A list of relevant signs and symptoms based on the NCCN guideline for invasive breast cancer was used to guide review and abstraction (localized bone pain, abdominal symptoms, abnormal physical exam of abdomen or pelvis, pulmonary symptoms, abnormal test results).⁹ The lack of a definitive statement of a sign or symptom was considered reason to categorize an imaging service as routine.

Data Analysis

Means, ranges, and percentages were generated as appropriate to summarize patient demographics and cancer disease and treatment characteristics. We calculated the overall number of patients in both systems who received at least one imaging service within the staging window as defined above, as well as by health system and by regions within the systems. We also calculated the overall totals of all three imaging service types (PET, CT, bone scan), as well as by health system and by regions within the systems. We compared results between the two systems and within regions of each system using χ^2 and analysis of

variance tests as appropriate. All analyses were performed using SAS software, version 9.2 (SAS Institute, Cary, NC).

Results

Demographic, Cancer Diagnosis, and Cancer Treatment Characteristics

Between 2010 and 2012, there were 10,010 patients with stages 0 to IIb breast cancer diagnosed within the two systems (KP regions: $n = 7,957$; IH: $n = 2,053$; Table 1). The average age at diagnosis within both systems was 60 years (standard deviation = 12 years). The overall majority of patients were white (60%), although the race/ethnicity of patients within KP differed significantly by region (KPSC: 51% white; KPNW: 89% white; KPMAS: 24% white, $P < .001$). Overall, the majority of patients (47%) had stage I disease, with small differences between the two systems (KP: 48% stage I, IH: 43% stage I, $P < .001$) and within regions. Ductal histology (including infiltrating ductal and infiltrating ductal, mixed) was the most common in both systems (KP: 81%; IH: 67%, $P < .001$), and the majority of patients had a tumor grade of moderately differentiated (KP: 43%; IH: 41%, $P < .001$). There were statistically significant differences between the systems for cancer treatment. Sixty-four percent of KP patients received a lumpectomy versus 74% of IH patients ($P < .001$), 32% of KP patients received chemotherapy versus 35% of IH patients ($P = .01$), and 49% of KP patients received radiation versus 62% of IH patients ($P < .001$). There was also statistically significant variation in treatment within the regions as shown in Table 1. Note that treatment characteristics do not include data from the KPMAS region; denominators for KP were adjusted accordingly.

Use of Imaging for Staging

Overall, 15% of patients (1,480 patients) received at least one imaging test (Table 2). Eight percent of patients received at least one imaging service in the presurgical period, and 7% in the postsurgical period. The most commonly used imaging modality was CT scan, accounting for 73% of all imaging tests. We found statistically insignificant differences between the two systems: 15% of KP patients received at least one imaging service versus 14% at IH ($P = .5$). There were statistically significant differences within regions for use of imaging services. Within the three KP regions, 15% of KPSC patients received at least one imaging service, 10% of KPNW patients received at least one, and 21% of KPMAS patients received at least one ($P < .001$). Within the 4 IH regions, 28% of UNR patients received at least one, versus 18% in USR, 16% in SWR, and 6% in UCR ($P < .001$).

Clinical Indication

Chart abstraction ($n = 129$; 16% of patients who received presurgical imaging) revealed that close to half (48%) of all imaging tests were performed in response to a clinical sign or patient-reported symptom (Table 3). For imaging services categorized as diagnostic, common reasons included response to abnormal laboratory and imaging findings (25%), palpable

masses or noted axillary lymphadenopathy (30%), abdominal pain (15%), chest pain (10%), other patient-reported pain (10%), and unexplained weight loss (10%). Overall, CT scans were most commonly categorized as diagnostic (70%), whereas PET scans were most commonly categorized as routine (96%). Bone scans were divided equally between diagnostic and routine. We found differences between the two systems for diagnostic versus routine use: 55% of imaging services at KP were performed in response to a sign or symptom versus 33% at IH. We also found differences within the regions. Within the three KP regions, 78% of imaging services in the KPSC region were performed in response to a sign or symptom, versus 53% in KPNW and 37% in KPMAS. Within the four IH regions, 40% of imaging services in the UCR and UNR regions were performed in response to a sign or symptom, versus 30% in USR and 20% in SWR (data not shown).

Discussion

The recent ASCO Top Five lists have drawn attention to use of low-value cancer care services, including use of imaging for staging of early breast cancer. We examined use of PET, CT, and radionuclide bone scan for staging within two large integrated health care systems. Overall, 15% of patients with breast cancer received a PET, CT, or radionuclide bone scan during the staging window, including 15% at KP and 14% at IH. This is somewhat less than has been reported in the literature. A recent study using SEER data linked with Medicare claims showed that 19% of patients with breast cancer diagnosed between 1992 and 2005 received preoperative imaging services.¹⁷ Other studies using claims data have shown that 15% to 42% of patients with breast cancer received imaging services for staging.^{19,20,24} Patient demographic and treatment characteristics (Table 1) vary significantly between the systems, particularly the race/ethnicity of patients, yet overall use of imaging for staging is quite similar at the system level. However, we found statistically significant variation within regions of each system, suggesting that imaging use may be driven by patient and provider factors distinct from the integrated setting.

Importantly, we were able to categorize use of imaging services as diagnostic or routine. Studies examining patterns of use commonly rely on data from administrative claims databases.^{17,19} These data sources do not provide information on diagnostic versus routine use (eg, clinical indication), a significant limitation. We found that approximately half of all imaging services in the presurgical period (48%) were used in response to a sign or symptom. For those imaging services categorized as diagnostic, clinical documentation in the electronic health record (EHR) included signs and symptoms that may be associated with metastatic disease, such as patient-reported pain and palpable masses. In these situations, use of imaging for staging in response to signs or symptoms represents guideline-concordant care.⁹ A recent survey showed that medical, radiation, and surgical oncologists consider clinical signs and symptoms to be important factors when deciding whether or not to use imaging for staging of early-stage breast cancer.²⁵ Our results illustrate the importance of capturing clinical indi-

Table 1. Demographic, Cancer Diagnosis, and Cancer Treatment Characteristics of Patients With Early-Stage Breast Cancer Within Kaiser Permanente and Intermountain Healthcare Regions

Characteristic	Total (N = 10,010)	KP Regions					IH Regions				
		KP Total (n = 7,957)	IH Total (n = 2,053)	P	KPSC (N = 6,474)	KPNW (N = 898)	KPMAS (n = 585)	UCR (n = 925)	UNR (n = 391)	USR (n = 405)	SWR (n = 332)
Age in years at diagnosis, mean ± SE (range)	60 ± 12 (22-99)	60 ± 12 (22-99)	60 ± 13 (24-97)	1.00	60 ± 12 (22-99)	60 ± 12 (25-91)	60 ± 12 (27-92)	59 ± 13 (24-97)	60 ± 13 (27-91)	59 ± 13 (26-92)	64 ± 13 (28-96)
Race/ethnicity, No. (%)				< .001							
White	6,039 (60%)	4,256 (53%)	1,783 (87%)		3,315 (51%)	800 (89%)	141 (24%)	776 (84%)	345 (88%)	351 (87%)	311 (94%)
Black	1,222 (12%)	1,213 (15%)	9 (0%)		807 (13%)	24 (3%)	382 (65%)	5 (1%)	3 (1%)	1 (0%)	0 (0%)
Asian	982 (10%)	954 (12%)	28 (1%)		887 (14%)	33 (4%)	34 (6%)	20 (2%)	3 (1%)	4 (1%)	1 (0%)
Hispanic	1,554 (16%)	1,417 (18%)	137 (7%)		1,372 (21%)	20 (2%)	25 (4%)	72 (8%)	26 (6%)	27 (7%)	12 (4%)
Other/unknown	213 (2%)	117 (2%)	96 (5%)		93 (1%)	21 (2%)	3 (1%)	72 (8%)	26 (6%)	27 (7%)	12 (4%)
Disease stage, No. (%)				< .001							
0	2,105 (21%)	1,697 (21%)	408 (20%)		1,426 (22%)	145 (16%)	126 (22%)	180 (19%)	105 (27%)	65 (16%)	58 (17%)
I	4,731 (47%)	3,847 (48%)	884 (43%)		3,146 (49%)	458 (51%)	243 (42%)	421 (46%)	162 (41%)	163 (40%)	138 (42%)
II	3,174 (32%)	2,413 (31%)	761 (37%)		1,902 (29%)	295 (33%)	216 (37%)	324 (35%)	124 (32%)	177 (44%)	136 (41%)
Grade, No. (%)				< .001							
Well differentiated	2,403 (24%)	1,914 (24%)	489 (24%)		1,563 (24%)	233 (26%)	118 (20%)	214 (23%)	113 (29%)	68 (17%)	94 (28%)
Moderately differentiated	4,292 (43%)	3,453 (43%)	839 (41%)		2,819 (43%)	359 (40%)	275 (47%)	414 (45%)	128 (33%)	169 (42%)	128 (39%)
Poorly or undifferentiated	2,963 (30%)	2,342 (30%)	621 (30%)		1,931 (30%)	240 (27%)	171 (29%)	256 (28%)	139 (35%)	144 (35%)	82 (25%)
Unknown	352 (3%)	248 (3%)	104 (5%)		161 (3%)	66 (7%)	21 (4%)	41 (4%)	11 (3%)	24 (6%)	28 (8%)
Histology, No. (%)				< .001							
Infiltrating ductal	6,154 (61%)	4,888 (61%)	1,266 (62%)		3,837 (59%)	679 (76%)	372 (64%)	555 (60%)	201 (52%)	300 (74%)	210 (63%)
Infiltrating ductal, mixed	1,667 (17%)	1,563 (20%)	104 (5%)		1,366 (21%)	183 (20%)	14 (2%)	57 (6%)	9 (2%)	4 (1%)	34 (10%)
Other	2,189 (22%)	1,506 (19%)	683 (33%)		1,271 (20%)	36 (4%)	199 (34%)	313 (34%)	181 (46%)	101 (25%)	88 (27%)
Surgery, No. (%) [*]				< .001							
Lumpectomy	6,209 (62%)	4,698 (64%)	1,511 (74%)		4,115 (64%)	583 (65%)	—	696 (75%)	264 (68%)	281 (69%)	270 (81%)
Mastectomy	3,202 (32%)	2,666 (36%)	536 (26%)		2,353 (36%)	313 (35%)	—	229 (25%)	125 (32%)	121 (30%)	61 (19%)
Surgery, NOS	14 (<1%)	8 (<1%)	6 (<1%)		6 (0.1%)	2 (0.2%)	—	0 (0%)	2 (0%)	3 (1%)	1 (0%)
Chemotherapy, No. (%)	3,068 (31%)	2,349 (32%)	719 (35%)	.011	2,088 (32%)	260 (29%)	—	282 (30%)	135 (35%)	174 (43%)	128 (39%)
Radiation, No. (%)	4,842 (48%)	3,579 (49%)	1,264 (62%)	< .001	3,047 (47%)	532 (59%)	—	591 (64%)	192 (49%)	287 (71%)	194 (58%)

Abbreviations: IH, Intermountain Healthcare; KP, Kaiser Permanente; KPMAS, KP Mid-Atlantic States; KPNW, KP Northwest; KPSC, KP Southern California; SWR, Southwest Region; UCR, Urban Central Region; UNR, Urban North Region; USR, Urban South Region.

^{*} Denominators for treatment variables (surgery, chemotherapy, radiation) exclude patients from Kaiser Permanente Mid-Atlantic States.

Table 2. Use of Imaging Services 30 Days Before Date of Diagnosis to 30 Days Post-Surgery for Patients With Early-Stage Breast Cancer Within Kaiser Permanente and Intermountain Healthcare Regions

Imaging Services	Total (N = 10,010)	KP Total (n = 7,957)	IH Total (n = 2,053)	P	KP Regions				IH Regions					P*
					KPSC (n = 6,474)	KPNW (n = 898)	KPMAS (n = 585)	P	UCR (n = 925)	UNR (n = 391)	USR (n = 405)	SWR (n = 332)		
Total Data Collection Period														
Any imaging, No. (%)†	1,480 (15%)	1,186 (15%)	294 (14%)	.5	975 (15%)	88 (10%)	123 (21%)	< .001	60 (6%)	110 (28%)	71 (18%)	53 (16%)	< .001	
CT‡	1,196 (12%)	1,002 (13%)	194 (9%)	< .001	857 (13%)	52 (6%)	93 (16%)	< .001	37 (4%)	95 (24%)	36 (9%)	26 (8%)	< .001	
PET	224 (2%)	124 (2%)	100 (5%)	< .001	83 (1%)	24 (3%)	17 (3%)	< .001	23 (2%)	14 (4%)	34 (8%)	29 (9%)	< .001	
Bone	555 (6%)	519 (7%)	36 (2%)	< .001	468 (7%)	20 (2%)	31 (5%)	< .001	8 (1%)	17 (4%)	6 (1%)	5 (2%)	< .001	
Total, No.	2,975	2,645	330	—	2,381	107	157	—	68	126	76	60	—	
CT	2,174	1,980	194	—	1,814	59	107	—	37	95	36	26	—	
PET	235	135	100	—	88	28	19	—	23	14	34	29	—	
Bone	566	530	36	—	479	20	31	—	8	17	6	5	—	
30 Days Before Date of Diagnosis to Initial Surgery														
Any imaging, No. (%)†	791 (8%)	667 (8%)	124 (6%)	< .001	563 (9%)	56 (6%)	48 (8%)	.04	32 (3%)	32 (8%)	33 (8%)	27 (8%)	< .001	
CT‡	647 (7%)	581 (7%)	66 (3%)	< .001	509 (8%)	34 (4%)	38 (6%)	< .001	16 (2%)	21 (5%)	17 (4%)	12 (4%)	< .01	
PET	141 (1%)	83 (1%)	58 (3%)	< .001	53 (1%)	17 (2%)	13 (2%)	< .001	16 (2%)	11 (3%)	16 (4%)	15 (5%)	< .05	
Bone	292 (3%)	269 (3%)	23 (1%)	< .001	252 (4%)	10 (1%)	7 (1%)	< .001	5 (1%)	9 (2%)	4 (1%)	5 (2%)	< .05	
30 Days Post-Surgery														
Any imaging, No. (%)†	739 (7%)	565 (7%)	174 (8%)	< .05	451 (7%)	37 (4%)	77 (13%)	< .001	28 (3%)	80 (20%)	39 (10%)	27 (8%)	< .001	
CT‡	574 (6%)	442 (6%)	132 (6%)	.1	364 (6%)	20 (2%)	58 (10%)	< .001	21 (2%)	76 (19%)	20 (5%)	15 (5%)	< .001	
PET	82 (1%)	41 (1%)	41 (2%)	< .001	30 (0%)	7 (1%)	4 (1%)	.4	7 (1%)	2 (1%)	18 (4%)	14 (4%)	< .001	
Bone	263 (3%)	250 (3%)	13 (1%)	< .001	216 (3%)	10 (1%)	24 (4%)	< .001	3 (0%)	8 (2%)	2 (0%)	0 (0%)	< .01	

Abbreviations: IH, Intermountain Healthcare; KP, Kaiser Permanente; KPMAS, KP Mid-Atlantic States; KPNW, KP Northwest; KPSC, KP Southern California; SWR, Southwest Region; UCR, Urban Central Region; UNR, Urban North Region; USR, Urban South Region.

* P value is derived from chi-squared test.

† The value displayed for 'Any Imaging' is defined as the number of patients with at least one imaging test performed. The number of patients with any imaging test is less than the sum of patients with CT, PET, or bone scan due to multiple tests performed on some patients.

‡ The number of unique patients with at least one imaging test is displayed for CT, PET, and bone scan.

cation when measuring adherence to guideline-recommended care. This is critical when assessing use of low-value services as described by the Choosing Wisely campaign. Failure to do so may result in biased results, leading to efforts to change practice patterns inappropriately. In addition, it is important to acknowledge that there is debate about how to approach patients with breast cancer who present with large cancers or clinically palpable nodes. Fuster et al demonstrated that PET CT led to a change in initial staging in 42% of women with large (> 3 cm) cancers,²⁶ and Groheux et al showed that stage was modified by

PET imaging 16% of the time in women with stage IIb breast cancer.²⁷ Within our data, 59% of PET scans ordered during the staging window were in patients with stage IIb breast cancer, 70% within KP and 49% within IH. It may not be unreasonable to consider PET imaging in stage IIb patients.

This study has several strengths. We examined a large sample from several geographically distinct regions, and supplemented analysis of structured data from EHRs with in-depth chart reviews. We examined data for patients diagnosed between January 1, 2010, and December 31, 2012. These data represent

Table 3. Chart Abstraction Results for Routine Versus Diagnostic (clinically indicated) Use of Imaging Services for Staging of Patients With Early-Stage Breast Cancer Within Kaiser Permanente and Intermountain Healthcare Regions

Test Category	Overall Totals (N = 129)		Kaiser Permanente (n = 89)		Intermountain Healthcare (n = 40)	
	Routine (%)	Diagnosis of Symptom or Problem (%)	Routine (%)	Diagnosis of Symptom or Problem (%)	Routine (%)	Diagnosis of Symptom or Problem (%)
CT only (n = 61)	30	70	24	76	47	53
PET only (n = 24)	96	4	100	0	91	9
Bone only (n = 12)	50	50	63	38	25	75
Multiple imaging test types (n = 32)	63	37	50	50	90	10
Total	52	48	45	55	67	33

NOTE. Kaiser Permanente regions include only Southern California, Northwest, and Mid-Atlantic States. Abbreviations: CT, computed tomography; PET, positron emissions tomography.

recent clinical activities and provide an up-to-date synopsis of imaging use patterns during staging for patients with breast cancer within these two health care systems. An additional strength is that we had access to complete patient data from the integrated model of both health care systems. Given that both systems provide comprehensive health care services, it is unlikely that patients sought care outside of KP or IH for additional clinical services. In addition, we were conservative in our categorization of services as diagnostic or routine. Lack of a definitive statement about a symptom or sign in the associated EHR clinician notes was considered reason to categorize the service as routine. This reduced the likelihood of overestimating the number of imaging services used for diagnostic purposes.

This study also has several limitations. We included only the nonrecommended imaging services included in the ASCO 2012 Top Five recommendation: PET, CT, and radionuclide bone scan. We did not look at chest x-ray, breast magnetic resonance imaging, or other imaging services. In addition, while we had data from the entire IH system, we included data from only three of seven KP regions. It is possible that data from other KP regions would produce different results. However, we were able to include data from KPSC, which is the largest KP region based on membership. An additional limitation is the small number of chart abstractions we conducted on presurgical use of imaging, 16% of those who received an imaging test (N = 129). However, our results did show clear divisions on diagnostic versus routine staging use of imaging. For example, PET scans were consistently categorized as routine staging; CT scans consistently categorized as diagnostic; and bone scans were consistently categorized as half staging, half diagnostic. This consistency in our results provides credibility. Finally, the generalizability of our results is limited given that these data represent patterns of use in two large, integrated health care systems. However, the US health care system is moving toward models of care that encourage integration and accountability. The results of this research are directly relevant to the growing number of these models of care delivery, such as patient-centered medical homes and accountable care organizations. In addition, results from this study provide a comparison to studies using large datasets from multiple sources, such as SEER-Medicare data.

In conclusion, we found similar overall use of imaging for staging of early-stage breast cancer in two large, integrated

health care systems, although each system has considerable intraregional variation. Approximately half of presurgical imaging services were used in response to a clinical sign or patient-reported symptom. Delivering high-quality cancer care, which includes limiting use of low-value cancer care services, is imperative given the rising costs of cancer care and the increasing number of patients with cancer and survivors.²⁸ However, in examining use of guideline-concordant care and implementing strategies to reduce unnecessary services, we must recognize the need for flexibility and physician autonomy.

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Authors' Disclosures of Potential Conflicts of Interest

Disclosures provided by the authors are available with this article at jop.ascopubs.org.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST**Use of Imaging for Staging of Early-Stage Breast Cancer in Two Integrated Health Care Systems: Adherence With a Choosing Wisely Recommendation**

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Appendix

Figure A1. Cohort flow diagram for patients with early-stage (stage 0-IIb) breast cancer diagnosed between January 1, 2010, and December 31, 2012 identified within Kaiser Permanente (Southern California, Northwest, and Mid-Atlantic States regions) and Intermountain Healthcare; N = 10,010.