Quality of post-treatment surveillance of early stage breast cancer in Texas

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Background. *Only annual mammography and physical examination are recommended for the post-treatment surveillance of early stage breast cancer.*

Methods. *We used Texas Cancer Registry–Medicare linked data (2001–2007) to identify physician visits and use of mammography, magnetic resonance imaging (MRI), computed tomography (CT), and positron emission tomography (PET) CT in patients ≥66 years old with ductal carcinoma in situ and stage I–III ductal carcinoma who underwent curative-intent operations. We also evaluated the trends in use of recommended and nonrecommended tests.*

Results. *We identified 8,598 patients with resected ductal carcinoma in situ (37.3%) or invasive ductal cancer (62.7%). Breast-conserving therapy was performed in 59%. Only 55% saw a physician twice a year for 2 years and underwent annual mammography for 2 consecutive years in the surveillance period. Mammography use decreased from 81% in 2001 to 75% in 2007 (P < .0001), and breast MRI use rose from 0.5% to 7.0% (P < .0001). For asymptomatic patients, the use of CT/MRI of the abdomen, chest, and head was 27%, 23%, and 22%, and this slightly increased during the study period. There was a significant increase in PET/PET CT use, from 2% in 2001 to 9% in 2007 (P < .0001). There was a concomitant decrease in bone scan use from 21% in 2001 to 13% in 2007 (P < .0001).*

Conclusion. *Adherence to evidence-based guidelines has been substandard and the use of nonrecommended tests has persisted over the study period. The rise in PET use and attendant decrease in bone scan implicates a population receiving PET scan in lieu of bone scan for surveillance of asymptomatic metastatic disease. In an elderly population of breast cancer patients in Texas, these findings imply both underuse and overuse. (Surgery 2013;154:214-25.)*

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The primary goal of post-treatment surveillance in patients with locoregional breast cancer is to identify local cancer recurrence and second primary breast cancers before the development of systemic disease.[1] Routine history and physical examination is effective in detecting locoregional recurrence after treatment of early stage breast cancer.[2-6] In a systematic review of studies evaluating the detection of locoregional recurrence, 30–40% of recurrences were detected on self-examination and 30% on physician-performed breast examination.[2,7-9] In addition to detecting locoregional recurrence, physician visits may improve compliance with mammography, provide psychosocial support, and allow for prompt management of side effects of treatment. Given the significant proportion of locoregional recurrences detected on physical examination and the additional potential benefits, the American Society of Clinical Oncology, the National Comprehensive Cancer Network, Health Canada, and the National Institute for Clinical Excellence (from the United Kingdom) recommend serial routine physical examination for the first 3–5 years (Table I).[10-13]

Although the effectiveness of mammography in the detection of locoregional recurrence has never been evaluated in randomized, controlled trials, strong observational data demonstrate that routine mammography decreases breast cancer mortality after treatment.[14-17] These findings are supported by 2 recent systematic reviews.[7,18] Although breast MRI is recommended for screening in certain high-risk

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Table I. Current post-treatment surveillance recommendations for treated early stage breast cancer

	History and physical	*Mammography*	*Breast MRI*	*CT/MRI head, chest, abdomen*	*CXR*	*PET/PET CT*	*Bone scan*
ASCO	q3–6 mos for years 1–3, q6–12 mos for years 4–5, then annually	No earlier than 6 mos after definitive treatment, then annually	NR	NR	NR	NR	NR
NCCN	q4–6 mos for 5 years, then annually	Starting 6–12 mos after definitive treatment, then annually	In high-risk persons	NR	NR	NR	NR
Health Canada	Regular, no interval defined	Annually	NR	NR	NR	NR	NR
NICE	Determined by patient and physician	Annually	NR	ND	ND	ND	ND

ASCO, American Society of Clinical Oncology; *CT*, computed tomography; *CXR*, chest x-ray; *MRI*, magnetic resonance imaging; *NCCN*, National Comprehensive Cancer Network; *NICE*, National Institute for Clinical Excellence; *ND*, not discussed; *NR*, not recommended; *PET*, positron emission tomography.

groups,[19] its effectiveness in post-treatment surveillance has not been documented and it is not recommended currently in lieu of mammography.

Two large, randomized, controlled trials showed that intensive surveillance for distant recurrence/metastatic disease (including routine chest x-ray, bone scan, and laboratory tests) did not improve survival or quality of life when compared with routine surveillance (history/physical examination and annual mammography).[20,21] Furthermore, without prospective clinical trials supporting their use, newer technologies such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET) to detect distant recurrence are not currently recommended in the absence of specific clinical indications.

Based on these data, the current recommendations for the post-treatment surveillance of breast cancer patients are summarized in Table I. In the United States, the American Society of Clinical Oncology and the National Comprehensive Cancer Network recommend (1) history and physical examination every 3–6 months for the first 3 years, every 6–12 months for the next 2 years, and then annually thereafter and (2) annual mammography, starting ≥6 months after the operation.[10,11]

Despite these recommendations, prior population-based studies have demonstrated both underuse of guideline-adherent measures and overuse of nonrecommended testing.[14,22] Using the Texas Cancer Registry (TCR; 2001–2007) and linked Medicare claims data, we assessed current adherence to evidence-based guidelines for post-treatment surveillance in older women after curative-intent treatment of breast cancer. In addition, we evaluated current patterns and trends in use of nonrecommended tests in asymptomatic patients. We hypothesized that newer technologies with unproven effectiveness would be used with increasing frequency to detect metastatic disease in asymptomatic patients.

METHODS

The institutional review boards at the University of Texas Medical Branch at Galveston and the Texas Department of State Health Services approved the study as did the privacy review board of the Centers for Medicare and Medicaid Services.

Data source. This study used TCR (2001–2007) and linked Medicare claims (2000–2009) data. Data from the Texas Cancer Registry (TCR)–Medicare linked database were used for the analysis. The Texas Cancer Registry–Medicare linked database is a linkage of two large population-based sources of data, performed under the guidance of the National Cancer Institute (NCI), the Texas Cancer Registry,[23] and the Medicare claims data collected by the Centers for Medicare and Medicaid Services.[24] This data set provides detailed information about elderly adults with cancer in Texas. Approximately 98% of all people aged 65 and older in TCR are matched with Medicare enrollment and claims files. TCR collects and provides information on participant demographics, cancer prevalence, cancer incidence, stage of disease, first course of therapy, and survival. The Medicare claims data include information on hospital stays, physician services, and hospital outpatient visits. Data use agreements have been signed with both data providers. The data used in this study include cancer patients diagnosed with locoregional breast cancer between 2001 and 2007 and their Medicare claims through 2009.[23] The Medicare files utilized were Medicare Part A inpatient billing claims (MEDPAR) and Medicare Part B outpatient claims, including the carrier claims and outpatient standard analytic file (SAF).[25]

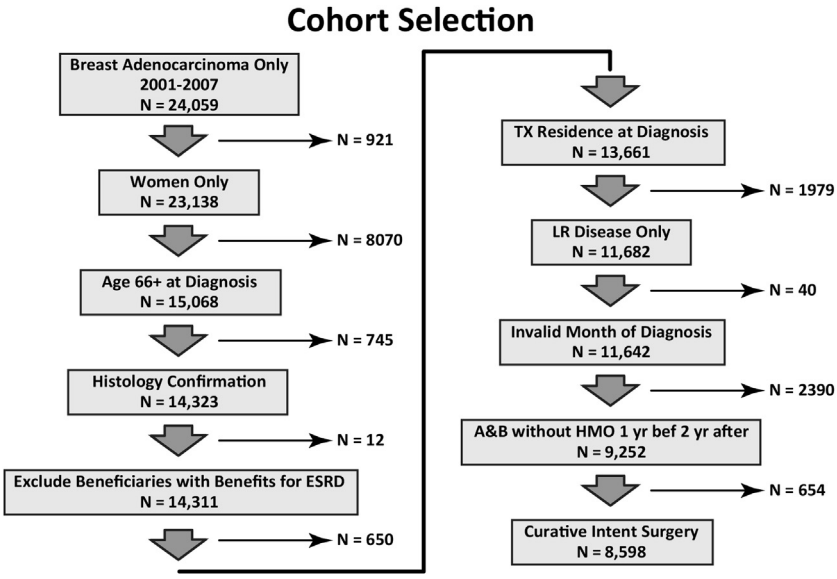

Fig 1. Cohort selection. We included only female residents of Texas aged ≥66 with histologically confirmed locoregional breast ductal adenocarcinoma or carcinoma in situ. Patients were excluded if they did not have Medicare Part A and B without HMO for 1 year before and 2 years after diagnosis or benefits based on disability or end-stage renal disease. Those with an invalid month of diagnosis or those who did not undergo curative intent surgery were excluded.

Cohort selection. The details of the cohort selection are shown in Fig 1. We used TCR–Medicare data from 2001 to 2007 to identify beneficiaries with ductal carcinoma in situ and invasive ductal carcinoma of the breast. We then applied the following inclusion/exclusion criteria: (1) Women only, (2) age ≥66 years, (3) histologic confirmation of adenocarcinoma, (4) Texas residents, (5) local (confined to the breast) or regional (involving adjacent structures or regional lymph nodes) disease, (6) part A and B without HMO for 1 year before and 2 years after diagnosis, (7) beneficiaries undergoing curative-intent surgery, and (8) excluded patients who underwent bilateral mastectomy at the initial operation or contralateral mastectomy within 1 month of the initial mastectomy. We excluded patients with benefits based on disability or end-stage renal disease and those with an invalid month of diagnosis. The final cohort had 8,598 women. Medicare claims were used from 2000 to 2009 to determine comorbidity in the year before diagnosis and to allow us to follow all patients for 2 full years.

Beneficiaries were considered to have undergone curative-intent surgery if they underwent breast-conserving therapy (BCT) or mastectomy, with or without adjuvant or neoadjuvant chemotherapy and/or radiation. Surgery was identified from Medicare claims by identifying *International Classification of Diseases, Ninth Revision Clinical Modification* (ICD-9-CM) procedure codes from the MEDPAR file and Current Procedural Terminology (CPT) codes from the carrier and outpatient SAF. BCT was defined using codes for segmental mastectomy, lumpectomy, quadrantectomy, wedge resection, excisional biopsy, or partial mastectomy with or without axillary node dissection or sentinel lymph node biopsy (ICD-9, 85.22-85.26; CPT, 19110, 19120, 19125, 19126, 19160, 19162, 19301, 19302). Mastectomy was defined using codes for total unilateral mastectomy with or without axillary lymph node dissection or sentinel lymph node biopsy (ICD-9, 85.4, 85.41, 85.43, 85.45, 85.47; CPT, 19180, 19182, 19200, 19220, 19240, 19303-19307). Patients undergoing bilateral mastectomy at the initial operation or contralateral mastectomy within 1 month of the initial mastectomy were excluded.

Outcome variables. The surveillance period began 2 months after definitive breast operation to eliminate routine postoperative physician visits, imaging done for staging before adjuvant therapy, or for postoperative complications. Months 3–14 were considered surveillance year 1 and months 15–26 were considered surveillance year 2. The primary outcome variable was overall adherence to current guidelines, which we defined as (1) ≥2 physician visits per year for 2 years and (2) 1 mammogram per year for 2 years. We also measured adherence to the individual components of the composite measure. We evaluated overall adherence and trends over time.

Table II. International Classification of Diseases, Ninth Revision Clinical Modification (ICD-9-CM) codes for non-guideline adherent testing, 2001–2007

Test	*ICD-9 code*	*Description*
Cross-sectional imaging (CT/MRI), abdomen	789.0, 789.1, 789.3, 788.0, 787.3, 799.4, 783.21, and 789.51-789.59	Abdominal pain, hepatomegaly, abdominal or pelvic swelling, mass, or lump, renal colic, flatulence, eructation, and gas pain, cachexia, loss of weight, malignant ascites
Cross-sectional imaging (CT/MRI), chest	306.1, 491.0, 611.71, 611.72, 786.2, 783.21, 786.3, 786.5, 786.50, 786.51, 786.52, 786.59, 786.05, 786.6, 786.9, and 799.4	Respiratory, simple chronic bronchitis, mastodynia, lump or mass in breast, cough, chest pain, chest pain, unspecified, precordial pain, painful respiration, discomfort in chest, pressure in chest, tightness in chest, shortness of breath, swelling, mass, or lump in chest, other symptoms involving respiratory system and chest, cachexia
Cross-sectional imaging (CT/MRI), head	249.3, 250.3, 307.81, 346.0-346.9, 350.2, 338.3, 386.0-386.9, 572.2, and 779.2	Secondary diabetes with other coma, diabetes with other coma, tension headache, migraine, atypical face pain, neoplasm related pain (acute) (chronic), Meniere's disease, hepatic coma, cerebral depression, coma, and other abnormal cerebral signs
Bone scan	338.3, 719.4, 733.1, 733.93, 733.94, 733.95, V15.51, 800-829, and V13.51	Neoplasm related pain (acute) (chronic), pain in joint, pathologic fracture, stress fracture of tibia or fibula, stress fracture of metatarsals, stress fracture of other bone, traumatic fracture, fracture of skull, pathologic fracture
PET/PET CT	All codes above as well as codes for 796.4, 799.4, and 780.7	Other abnormal clinical findings, cachexia, malaise and fatigue

CT, Computed tomography; *MRI*, magnetic resonance imaging; *PET*, positron emission tomography.

Mammogram claims in each surveillance period were identified in the carrier and outpatient SAF claims using CPT codes 76090, 77051, 77055, 76091, 76092, 77052, 77056, 77057, 76095, and 76096. Physician office visits were identified using CPT codes for outpatient evaluation and management (99201-99215) or outpatient consultation (99241-99245). Physician specialty was evaluated using the Medicare Health Care Financing Administration specialty claims codes. We categorized specialty as primary care (PCP: general practice, family practice, internal medicine, geriatrics), medical oncology (medical oncology, hematology/oncology), radiation oncology, and surgery (general surgery, surgical oncology).

We also evaluated the use of nonrecommended tests. These tests were identified in the carrier and outpatient SAF files and classified as follows: Breast MRI (CPT: 76093, 76094, 77058, 77059), CT/MRI abdomen (74150, 74160, 74170, 74175, 74181, 74182, 74183, 74185), CT/MRI chest (CPT: 71550, 71551, 71552, 71250, 71260, 71270), CT/MRI head (CPT: 70450, 70460, 70470, 70533, 70544, 70545, 70546, 70551, 70552), PET/PET CT (CPT: 78810, 78811, 78812, 78813-78816, HCPCS code: G0252, G0253, G0254), and bone scans (CPT: 78305, 78306, 78315, 78320).

Covariates. Patient demographic characteristics included age, gender, race/ethnicity, and income/education. The Charlson comorbidity index was used as a measure of patient comorbidity. Tumor stage included carcinoma in situ, localized disease, and regional disease. Other tumor characteristics included tumor size, nodal status, and tumor differentiation. As defined herein, all patients underwent either mastectomy or BCT. For the overall cohort, we determined the percentage of patients who received adjuvant chemotherapy. For patients undergoing BCT, the percentage of patients receiving radiation was also determined.

Symptoms were identified from carrier Medicare files, MEDPAR, and outpatient files using ICD-9-CM diagnosis codes in the 3 months before the individual test date. This was done in an attempt to evaluate the proportion of tests done without symptoms or clear indication. For example, if an abdominal CT was done on March 1, 1999, we looked for the symptoms that would prompt abdominal CT (Table II; abdominal pain, hepatomegaly, abdominal or pelvic swelling, mass, or lump, renal colic, flatulence, eructation, and gas pain, cachexia, loss of weight, malignant ascites) from January 1, 1999, to the date of the study. The codes evaluated for each test are listed in Table II.

Statistical analysis. We calculated summary statistics for the overall cohort. Unadjusted and adjusted associations between patient, tumor, and treatment characteristics and receipt of guideline adherent post-treatment surveillance for the composite measure as well as the individual components of mammography and physician visits were examined. Multivariate logistic regression was used to determine factors independently associated with the receipt of guideline adherent and nonrecommended surveillance.

We evaluated overall use of the nonrecommended tests in the 2-year time period and trends in use based on year of diagnosis as well as the total number of each test type received in the 2-year surveillance period for the whole group. Because a test may have been prompted by symptoms and therefore would be considered indicated, we searched the carrier, MEDPAR, and outpatient SAF for symptoms occurring in the 3 months before the tests. Table II shows the symptoms we evaluated in the 3 months before a given test for each test type. We used a Cochran–Armitage test to evaluate trends in adherence or use of nonrecommended tests over time.

For mammography, we used a Kaplan–Meier time-to-event analysis to evaluate patterns of regular surveillance. We measured the time from the start of the surveillance period to the first mammogram and the median time to first mammography. In those patients who received an initial mammography, the time to a second mammogram, if it was obtained, was evaluated in similar fashion. Patients were censored when they were no longer eligible for surveillance. Criteria for censoring included death or recurrence. Recurrence was considered to have occurred if patients started nonadjuvant chemotherapy (chemotherapy >6 months after definitive breast operation or >1 month after the date of last adjuvant treatment), had a second breast resection for a diagnosis of cancer, or entered hospice. Because the Kaplan–Meier analysis extended beyond 2 years, patients were also censored when they had no further follow-up (ie, a patient diagnosed in 2004 would not have Medicare claims beyond 3 years from diagnosis).

All *P* values were from 2-sided tests. All analyses were performed with *SAS* version 9.2 (SAS Inc, Cary, NC).

RESULTS

Demographic, tumor, and primary treatment characteristics (Table III). We identified a total of 24,059 patients from the TCR with the diagnosis of invasive ductal adenocarcinoma or ductal carcinoma in situ from 2001 to 2007. After applying the exclusion criteria shown in Fig 1, the final cohort was composed of 8,598 patients.

The mean age of the cohort was 75.4 ± 6.6 years and the distribution by age group is shown in Table III. The majority of the patient population (88.5%) was white. Most patients (66.8%) had a Charlson comorbidity score of 0.

Of these 8,598 patients, 37% had ductal carcinoma-in-situ. Of those with invasive cancer, 72% had localized disease, and 28% had regional disease. Tumor size, differentiation, and lymph node status are shown in Table III. BCT was performed in 41% of patients and mastectomy in 59% of patients. Only 63% of those who underwent breast conservation therapy also underwent adjuvant radiation therapy, and its use decreased with increasing age from 69% in patients <70 to 32% in patients ≥85 ($P < .0001$). Fourteen percent of the overall cohort and 45% of patients with regional breast cancer received adjuvant chemotherapy. Forty-nine patients died before the start of the surveillance period; 92% survived for the entire 2-year surveillance period.

Overall guideline adherence (Table III). Overall, only 55.3% of patients were guideline-adherent by our measure. Guideline adherence actually decreased over the study period from 58% in 2001 to 53% in 2007 ($P < .0001$).

Table III presents the unadjusted analysis of the factors associated with guideline adherence. Guideline adherence decreased as age increased, from 63% of patients <70 to 31% in patients >85 ($P < .0001$). Guideline adherence decreased with increasing comorbidity ($P < .0001$) and increased in the higher education and income quartiles ($P < .0001$). Guideline adherence was highest for ductal carcinoma in situ and decreased as stage advanced, with only 44% of patients with regional disease adhering to this composite measure ($P < .0001$). Patients undergoing BCT were more likely to undergo appropriate surveillance than those undergoing mastectomy ($P < .0001$). Likewise patients receiving adjuvant radiation after BCT and patients receiving chemotherapy were more likely to adhere to guidelines ($P < .0001$).

In a multivariate analysis (Table IV), younger age, non-Hispanic race, lower Charlson comorbidity score, breast conservation therapy, and regular visits with a medical oncologist or PCP were independently associated with guideline adherence.

Use of mammography and physician visits. Although 79% of patients received ≥1 surveillance

Table III. Bivariate analysis of factors predicting guideline adherence*

Factor	N *(%)*	*Guideline adherence* N *(%)*	P *value*
Patient characteristics			
Total cohort	8,598 (100)	4,756 (55.3)	
Age (y)			<.0001
Mean	75.4 ± 6.6	NA	
66–69	1,943 (22.6)	1,218 (62.7)	
70–74	2,266 (26.4)	1,409 (62.2)	
75–79	2,169 (25.2)	1,200 (55.3)	
80–84	1,383 (16.1)	674 (48.7)	
≥85	837 (9.7)	255 (30.5)	
Race			<.0001
White	7,612 (88.5)	4,294 (56.4)	
Black	612 (7.1)	298 (48.7)	
Hispanic	274 (3.2)	110 (40.2)	
Other	100 (1.2)	54 (54.0)	
Income (quartile)			.0004
1	2,121	1,122 (52.9)	
2	2,118	1,144 (54.0)	
3	2,124	1,193 (56.2)	
4	2,122	1,250 (58.9)	
Education (quartile)			<.0001
1	2,122	1,079 (50.9)	
2	2,121	1,146 (54.0)	
3	2,125	1,236 (58.2)	
4	2,117	1,248 (59.0)	
Charlson Comorbidity Index			<.0001
0	5,746 (66.8)	3,374 (58.7)	
1	1,883 (21.9)	1,002 (53.2)	
2	591 (6.9)	253 (42.8)	
≥3	378 (4.4)	127 (33.6)	
Tumor characteristics			
Stage			<.0001
CIS	3,207 (37.3)	1,956 (61.0)	
Local	3,898 (45.3)	2,139 (54.9)	
Regional	1,493 (17.4)	661 (44.3)	
Mean size (n = 6,654)	21.3, +/− 21.1	NA	<.0001
Differentiation			
Well/moderate	4,554 (53.0)	2,570 (56.4)	.03
Poor	1,716 (20.0)	936 (54.6)	.47
Nodal status (n = 1,845)			<.0001
Negative	2,369 (47.0)	1,612 (68.1)	
Positive	397 (7.9)	233 (58.7)	
Treatment characteristics			
Type of operation			<.0001
Mastectomy	3,553 (41.3)	1,565 (44.1)	
Breast conservation therapy	5,045 (58.7)	3,191 (63.3)	
Radiation after breast conservation			
Adjuvant radiation	3,191 (63.3)	2,299 (72.1)	<.0001
No adjuvant radiation	1,854 (36.7)	843 (45.5)	
Adjuvant chemotherapy			
Chemotherapy	1,186 (55.3)	616 (51.9)	.01
No chemotherapy	3,842 (44.7)	570 (14.8)	

*Guideline adherence defined as annual mammography for 2 years and 2 physician visits per year for 2 years.

mammography in the 2 years after the start of the surveillance period, only 57% of patients received an annual mammogram for 2 consecutive years. When we evaluated the use of regular mammography alone, age, non-Hispanic race, lower Charlson comorbidity score, breast conservation

Table IV. Multivariate logistic regression analysis of factors predicting guideline adherence

	Predictors of overall guideline adherence		*Predictors of mammography adherence*	
	OR	*95% CI*	*OR*	*95% CI*
Age (y)				
<70	2.52	2.09–3.04	2.59	2.15–3.12
70–74	2.45	2.04–2.95	2.51	2.09–3.01
5–79	2.15	1.79–2.58	2.24	1.87–2.69
80–84	1.73	1.42–2.10	1.77	1.46–2.15
>85	Reference	Reference	Reference	Reference
Race				
White	1.91	0.67–1.58	1.92	1.46–2.53
Black	1.57	0.52–1.29	1.62	1.18–2.22
Other	1.87	1.12–3.10	1.88	1.14–3.12
Hispanic	Reference	Reference	Reference	Reference
Education (quartile)				
1	Reference	Reference	Reference	Reference
2	1.04	0.91–1.18	1.06	0.93–1.21
3	1.15	1.00–1.32	1.16	1.01–1.32
4	1.15	1.00–1.32	1.14	0.99–1.30
Charlson Comorbidity Index				
0	Reference	Reference	Reference	Reference
1	0.81	0.72–0.91	0.79	0.71–0.89
2	0.62	0.52–0.75	0.60	0.50–0.73
3	0.46	0.36–0.59	0.47	0.37–0.59
Stage				
CIS	Reference	Reference	Reference	Reference
Local	0.77	0.69–0.85	0.74	0.67–0.83
Regional	0.52	0.45–0.60	0.50	0.44–0.58
Treatment				
BCT versus Mastectomy	2.04	1.85–2.25	2.06	1.87–2.28
Regular physician visits*				
Medical oncologist (yes versus no)	2.59	2.34–2.87	2.39	2.16–2.64
PCP (yes versus no)	2.06	1.87–2.27	1.81	1.65–1.99
Year of diagnosis	0.94	0.91–0.96	0.93	0.91–0.95

*Two visits a year for 2 years.
BCT, Breast conservation therapy; *CI*, confidence interval; *CIS*, carcinoma in situ; *OR*, odds ratio; *PCP*, primary care physician.

therapy, and visits with a medical oncologist or PCP predicted annual mammography in the 2 years after diagnosis.

Figure 2, *A* shows a Kaplan–Meier curve demonstrating the time to first mammography. 8,536 patients survived without recurrence to the beginning of the surveillance period. There were 1,837 patients censored during the surveillance period. Of these, 918 (50.0%) were censored for death/recurrence and 919 (50.03%) were lost to follow-up without receipt of a mammogram in the time which they were followed. The median time from the start of surveillance to receipt of first mammogram was 9 months. Seventy-three percent of patients underwent mammography within 12 months of the start of surveillance. However, of 5,713 patients who underwent ≥1 mammography, only 47% underwent repeat mammogram within a year of the first (Fig 2, *B*). The median time from first to second mammogram was 12 months after the first mammogram, consistent with current recommendations.

Most patients (98%) had ≥1 physician visit within 2 years of the start of the surveillance period and nearly 90% of patients saw a physician twice a year in the 2 years after treatment. The majority of patients (58%) saw a PCP, 42% saw a medical oncologist, and 18% saw a surgeon at least twice a year for 2 years.

Use of nonrecommended tests for distant and locoregional recurrence. Table V shows the number of patients who underwent CT/MRI abdomen, CT/MRI chest, CT/MRI head, PET/PET CT, and bone scans at any point in the 2-year follow-up period. It also demonstrates the total number of each test type performed in

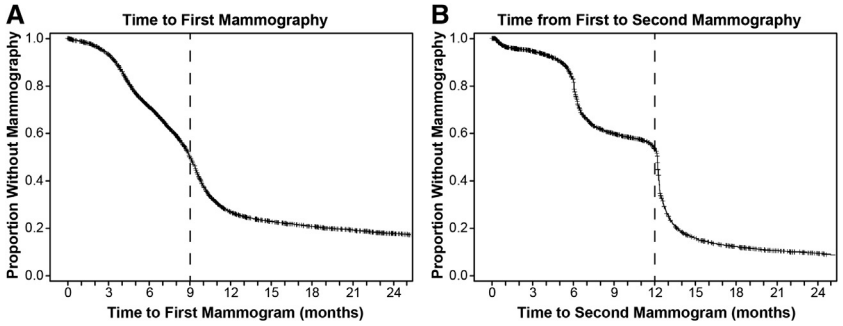

Fig 2. Kaplan–Meier analysis of time to first and second mammography. Patients were censored for recurrence, death, or if date of last follow-up was before any mammogram because they were no longer eligible for surveillance. Recurrence was considered to have occurred if patients started nonadjuvant chemotherapy (chemotherapy >6 months after definitive breast operation or >1 month after date of last adjuvant treatment), had a second breast resection for a diagnosis of cancer, or entered hospice. (*A*) Time to first mammogram. Surveillance period starts 2 months from date of surgery (n = 8,536; censored n = 1,837). Seventy-three percent of patients received a mammogram within first 12 months of surveillance. Median time to mammogram was 9 months; 5,714 patients received ≥1 mammogram. (*B*) Time to second mammogram after receipt of first mammogram (n = 6,699; censored n = 986). Forty-seven percent of patients received a second mammogram in the year after their first. Median time from first to second mammogram was 12 months.

Table V. Non–guideline-adherent testing in asymptomatic patients

	Patients with ≥1 test in 2-year surveillance period, n *(%)*	*Total number of tests in the 2-year surveillance period*	*Tests done in asymptomatic patients,* n *(%)*
CT/MRI abdomen	2,277 (26.48)	10,130	9,853 (97.3)
CT/MRI chest	1,969 (22.90)	8,689	6,249 (71.9)
CT/MRI head	1,893 (22.02)	8,055	7,774 (96.5)
PET/PET CT	566 (6.58)	2,129	2,116 (99.4)
Bone scan	1,462 (17.00)	5,106	4,938 (96.7)

CT, Computed tomography; *MRI*, magnetic resonance imaging; *PET*, positron emission tomography.

the 2-year time period and the percentage of tests without documented symptoms to prompt the test in the 3 months before the test. Cross-sectional imaging of the abdomen, chest, and head were used in >20% of all patients in the 2-year surveillance period. PET/PET CT was used in 7% of patients and bone scans in 17%. The majority of all non–guideline-recommended tests were obtained in the absence of symptoms. This finding was especially pronounced for PET/PET CT (99%) and bone scan (97%), which are typically used to identify occult distant metastases.

Time trends in the use of various nonrecommended tests are shown in Fig 3. We identified a dramatic increase in PET/PET CT use from 2% in 2001 to 9% in 2007 ($P < .0001$). Bone scan use decreased proportionately to the increase in PET/PET CT use, from 21% of patients in 2001 to only 13% in 2007 ($P < .0001$); 60% of PET scans were performed in patients who never received a bone scan. There was a slight increase in the use of cross-sectional imaging (CT/MRI) of the abdomen, chest, and head over time, but this was not statistically significant (Fig 3, *A*). In patients with regional breast cancer, the use of nonrecommended tests was higher. There were 37% who underwent CT/MRI abdomen, 39% underwent CT/MRI chest, 24% underwent CT/MRI head, 15% underwent PET/PET CT, and 31% underwent bone scans. Use of nonrecommended tests increased more dramatically over time in this subgroup with a significant increase in PET/PET CT from 4% in 2001 to 15% in 2007 ($P < .0001$) over time. Bone scan use decreased from 41% in 2001 in 23% in 2007 ($P < .0001$; Fig 3, *B*).

Mammography use decreased over the study period from 81% of patients in 2001 to 75% of patients in 2007 ($P < .0001$ for overall trend). During this time, there was a concomitant increase in the use of breast MRI, from 0.5% of patients in 2001 to 7.0% in 2007 ($P < .0001$; Fig 4). Of the 155 breast MRIs obtained, 91% were done in

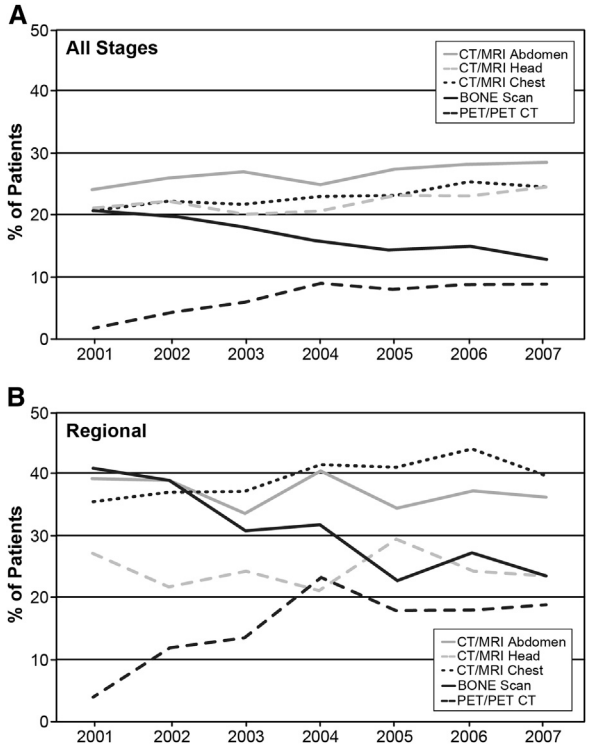

Fig 3. (*A*) Trends in nonrecommended surveillance testing in asymptomatic patients from 2001 to 2007. Positron emission tomography (PET)/PET computed tomography (CT) use increased from 2% in 2001 to 16% in 2007, whereas bone scan use decreased from 21% in 2001 to 13% in 2007 ($P < .0001$). There was a non-significant increase in the use of cross-sectional imaging of the abdomen, chest, and head over the study period. (*B*) Trends in nonrecommended surveillance testing in asymptomatic patients with regional disease from 2001 to 2007. For patients with regional disease, the increase in PET/PET CT use was more dramatic, from 4% in 2001 to 19% in 2007. Bone scan decreased from 41% in 2001 to 23% in 2007 ($P < .0001$). Again, the use of cross-sectional imaging slightly increased during the study period.

patients who also had mammography. Neither mammography nor MRI was performed in 16% of the overall cohort.

Overall, breast MRI was used more commonly in patients undergoing breast conservation than those who underwent mastectomy (3% vs 1%; $P < .0001$). For patients undergoing breast conservation therapy, the use of mammography decreased from 87% in 2001 to 82% of patients in 2007 ($P < .0001$). The rise in MRI use was more dramatic in this population, from 0.3% of patients diagnosed in 2001 to 8.3% in 2007 ($P < .0001$).

The use of breast MRI was greater among patients who were adherent to physician visit and mammography guidelines, whereas the use

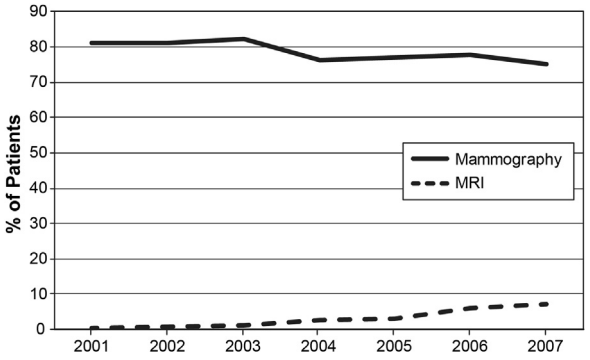

Fig 4. Trends in use of mammography and magnetic resonance imaging (MRI) over study period (2001–2007). MRI use increased from 0.5% in 2001 to 7.0% in 2007, whereas mammography use decreased from 81% in 2001 to 75% in 2007 ($P < .0001$).

of cross-sectional imaging of the abdomen, chest, or head and PET/PET CT were higher in non–guideline-adherent patients (Table VI). Bone scan use was equal between the 2 groups.

DISCUSSION

After curative treatment for early stage breast cancer, only 55% of older women in Texas met the minimal post-treatment surveillance guidelines of 2 physician visits annually for 2 years and 1 mammogram per year for 2 years. Although 90% of women saw a physician twice a year over the 2-year surveillance period, only 57% received 2 consecutive mammograms in the 2-year follow-up period. Even more concerning was that both guideline adherence and the use of mammography decreased slightly over the time period.

Our results illustrate not only persistence in the use of inappropriate or non–guideline-adherent tests, but also demonstrate a concerning increase over time. To our knowledge, our study is the first to document practice patterns in the use of new technologies in the post-treatment surveillance of asymptomatic breast cancer patients, including breast MRI for locoregional recurrence and PET/PET-CT for detection of metastatic disease.

A previous population-based study of SEER-Medicare data by Panageas et al[26] noted a modest use of breast MRI (1.4%). Our study documented a nearly 14-fold increase in the use of breast MRI over the study period. Like mammography, targeted breast MRI can be used in the identification of local recurrence. Recent studies evaluating breast MRI for the detection of ipsilateral local recurrences in patients undergoing breast conservation therapy document improved sensitivity and specificity when compared with mammography

Table VI. Non–guideline-adherent testing by composite guideline adherence

Test	Total number of patients tested	Guideline adherent (n = 4,756) n (%) with test	Non-guideline adherent (n = 3,842) n (%) with test	P value
Breast MRI	200	130 (2.7)	70 (1.8)	.005
CT/MRI, abdomen	2,277	1,158 (24.4)	1,119 (29.1)	<.0001
CT/MRI chest	1,969	1,001 (21.1)	968 (25.2)	<.0001
CT/MRI head	1,893	867 (18.2)	1,026 (26.7)	<.0001
PET/PET CT	566	273 (5.7)	293 (7.6)	.0005
Bone scan	1,462	805 (16.9)	657 (17.1)	.83

CT, Computed tomography; *MRI*, magnetic resonance imaging; *PET*, positron emission tomography.

for the detection of local recurrence.[27] However, the comparative effectiveness of the 2 modalities on breast cancer survival has not been studied. We demonstrated a dramatic rise in targeted breast MRI use, which was most striking in women undergoing BCT. MRI was done in addition to mammography in the majority of cases. In addition, mammography use decreased, demonstrating an overall decrease in localized breast imaging and appropriate surveillance, despite the increase in MRI. Further studies of the cost effectiveness of MRI in post-treatment surveillance for local recurrence, especially after BCT, are necessary before any change in current surveillance recommendations can be made.

Prompted by retrospective evidence that intensive surveillance for metastatic disease did not improve survival,[5,28-32] 2 large Italian randomized controlled trials[20,21] demonstrated no survival or quality-of-life benefit when intensive surveillance was used to detect asymptomatic metastases over a conventional follow-up strategy with physical examination and mammography. Panageas et al[26] demonstrated a 1.2% use of PET scans in treated breast cancer patients between 1998 and 2003. We are the first to document a dramatic, nearly 5-fold, increase in the use of PET/PET-CT from 2001 to 2007 with a concomitant decreased use of bone scans, with the vast majority being done in the absence of symptoms or obvious clinical indications. A systematic review of PET/PET-CT in post-treatment surveillance documented a higher sensitivity, specificity, and accuracy in identifying tumor recurrence with this modality compared with conventional testing.[33] Despite these findings, the cost effectiveness of PET/PET CT in the post-treatment surveillance of breast cancer patients is unknown. Because early detection of metastatic disease has not been shown to improve survival or quality of life, the more expensive PET/PET CT is not likely to be cost effective.

Finally, our data show that the use of cross-sectional imaging was more common in women who were not adherent to current surveillance guidelines. Altogether, these findings demonstrate misallocation of resources. In an increasingly cost-conscious healthcare environment, the inappropriate use of expensive, unproven testing amongst Medicare recipients represents a potential target for intervention.

Our findings are consistent with previous studies documenting underuse of guideline-recommended mammography. Only 79% of patients in our cohort underwent a postoperative mammogram at any time in the 2 years after treatment, demonstrating little improvement since a 1997 study by Hillner et al,[22] in which 76% of women <64 years underwent mammography in the first 18 months after curative treatment. In addition, 16% of patients never received any imaging to detect local recurrence (mammography or breast MRI) consistent with a study by Schapira et al,[34] in which 15% of Medicare patients diagnosed with breast cancer in 1991 never received a follow-up mammogram after curative intent surgery.

Consistent with previous studies, mammography use decreased with increasing age and was less likely to be performed in women with more advanced stage disease and in women undergoing mastectomy versus BCT.[34,35] However, the use of non–guideline-adherent tests was increased. This may represent the "risk-treatment paradox," in which patients with less aggressive disease are more likely to receive care than higher risk patients with limited survival. Our data suggest that providers are concerned about metastatic disease in this higher risk group but fail to monitor appropriately for locoregional recurrence. The reasons underlying this finding are not clear, but may be related to a perception that post-treatment local surveillance would not improve survival for the eldest elderly patients with limited

expected survival or patients with more advanced breast cancer in whom distant recurrence may be more likely. Previous studies have also suggested that this may be due to lack of understanding by practitioners of evidence-based practices or miscalculations of risks and benefits. Finally, our study confirms findings of a previous study in which adherence to evidence-based mammography guidelines was improved when patients received follow-up with a primary care physician or medical oncologist.[36]

Our study has several limitations. As with any administrative dataset, we are limited in our ability to precisely identify the clinical circumstance in which study tests were obtained and cannot determine the appropriateness of a particular test at the individual patient level. For example, many of these studies may have been obtained under the auspices of a controlled clinical trial where cross-sectional imaging is required before enrollment and start of therapy, which we are unable to identify using administrative data. However, given the age of the patient population in our study, many were likely ineligible for clinical trials. In addition, many were treated in the community setting and may have been less likely to participate in clinical trials. Finally, enrollment in clinical trials for any cancer is an ongoing challenge, and enrollment in general has not increased over our study period. Even if patients are participating in clinical trials, we do not expect that the proportion of patient presenting changed significantly over time, given these considerations. Although some proportion of the use of PET and other cross-sectional imaging may be attributable to clinical trial participation, the observed increasing trends in use—especially the nearly 5-fold increase in the use of PET scans—cannot be explained by enrollment in clinical trials.

In addition, we cannot be certain that our tests were obtained in the complete absence of a clinical indication. We excluded any test that was performed for possible symptoms of metastatic disease or locoregional recurrence in the 3 months before testing. We recognize that symptoms are likely undercoded in claims data and, as such, we may not be capturing all symptoms. In addition, our algorithm for detection of symptoms has not been validated. We were purposefully inclusive of even vague symptoms. We do not suspect that the patient population changed over time with regard to symptomatology. As such, the rising trend remains concerning.

Finally, the advanced age of our population of elderly breast cancer survivors limits our generalizability. Practice patterns in the management of patients with potentially limited life expectancy certainly may differ from management of the general population, and in fact we observed an age-dependent decrease in guideline adherence. In addition, the use of breast MRI for post-treatment surveillance is likely greater for younger women owing to increased breast density and subsequent limitations of mammography in this population. We suspect that, if women of all ages were included, trends in the use of MRI over time would increase at a greater rate.

In conclusion, our population-based study illustrates that a significant population of older patients in Texas are not receiving appropriate post-treatment surveillance and that is actually decreasing over time. In addition, the use of nonrecommended tests to identify metastatic disease, particularly PET/PET-CT, has risen since the beginning of the last decade. Curtailing the use of these tests can improve resource allocation in the post-treatment surveillance of breast cancer patients in Texas. Finally, we observed a rising use in MRI and a concomitant decreased use of mammography. Further studies should be done to assess the comparative effectiveness of MRI versus mammography in the post-treatment surveillance of breast cancer patients.

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