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Quality of Post-Treatment Surveillance of Early Stage Breast Cancer in Texas

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Abstract

BACKGROUND—Only annual mammography and physical exam 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, MRI, CT, and PET CT scans in patients 66 and older with ductal carcinoma-in-situ (DCIS) and stage I-III ductal carcinoma who underwent curative-intent surgery. We also evaluated the trends in use of recommended and non-recommended tests.

RESULTS—We identified 8,598 patients with resected DCIS (37.3%) or invasive ductal cancer (62.7%). Breast-conserving therapy (BCT) was performed in 58.7%. Only 55.3% saw a physician twice a year for two years and underwent annual mammography for two consecutive years in the surveillance period. Mammography use decreased from 81.0% in 2001 to 75.2% in 2007 ($p<0.0001$), and breast MRI use rose from 0.5% to 7.0% ($p<0.0001$). For asymptomatic patients, the use of CT/MRI of the abdomen, chest, and head was 26.5%, 22.9%, and 22.0%, and this slightly increased during the study period. There was a significant increase in PET/PET CT use, from 1.9% in 2001 to 8.9% in 2007 ($p<0.0001$). There was a concomitant decrease in bone scan use from 20.8% in 2001 to 13.0% in 2007 ($p<0.0001$).

CONCLUSIONS—Adherence to evidence-based guidelines has been substandard and the use of non-recommended 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.

Keywords

breast cancer; surveillance; treatment; mammography

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INTRODUCTION

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 exam 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 exam and the additional potential benefits, the American Society of Clinical Oncology (ASCO), the National Comprehensive Cancer Network (NCCN), Health Canada, and the National Institute for Clinical Excellence (NICE, United Kingdom) recommend serial routine physical exam for the first 3-5 years (Table 1).¹⁰⁻¹³

While 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 two recent systematic reviews.^{7, 18} While breast MRI is recommended for screening in certain high risk groups,¹⁹ its effectiveness in post-treatment surveillance has not been documented and it is currently not recommended 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 to routine surveillance (history/physical exam and annual mammography).^{20, 21} Furthermore, without prospective clinical trials supporting their use, newer technologies such as CT, MRI, and PET scans to detect distant recurrence are not currently recommended in the absence of specific clinical indications.

Based on the above data, the current recommendations for the post-treatment surveillance of breast cancer patients are summarized in Table 1. In the U.S., ASCO and the NCCN recommend: 1) history and physical exam every 3-6 months for the first three years, every 6-12 months for the next two years, and then annually thereafter; and 2) annual mammography, starting at least 6 months after surgery.^{10, 11}

Despite these recommendations, prior population-based studies have demonstrated both underuse of guideline-adherent measures and overuse of non-recommended testing.^{14, 22} Using the Texas Cancer Registry (2001-2007) and linked Medicare claims data, we assessed current adherence to evidence-based guidelines for post-treatment surveillance in older women following curative-intent treatment of breast cancer. In addition, we evaluated current patterns and trends in use of non-recommended 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

This study was determined to be exempt from review by the Institutional Review Board at the University of Texas Medical Branch.

Data Source

This study used Texas Cancer Registry (TCR, 2001-2007) and linked Medicare claims (2000-2009) data. TCR is a statewide population-based registry that collects cancer incidence, staging, and initial treatment data for patients diagnosed with cancer in Texas.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).²⁴

Cohort Selection

The details of the cohort selection are shown in Figure 1. We used TCR-Medicare data from 2001-2007 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 and older, 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 one year before and two years after diagnosis, 7) beneficiaries undergoing curative-intent surgery, and 8) patients who underwent bilateral mastectomy at the initial operation or contralateral mastectomy within one 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 2000-2009 in order to determine comorbidity in the year prior to diagnosis and to allow us to follow all patients for two full years.

Beneficiaries were considered to have undergone curative-intent surgery if they underwent breast-conserving therapy 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. Breast-conserving therapy 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 one month of the initial mastectomy were excluded.

Outcome Variables

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

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, 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 non-recommended 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, sex, race/ethnicity, and income/education. 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 above, all patients underwent either mastectomy or breast-conserving therapy. For the overall cohort, we determined the percentage of patients who received adjuvant chemotherapy. For patients undergoing breast-conserving therapy, the percentage of patients receiving radiation was also determined.

Symptoms were identified from carrier Medicare files, MEDPAR, and outpatient files using International Classification of Diseases, Ninth Revision Clinical Modification (ICD-9-CM) diagnosis codes in the three months prior to 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 a CT abdomen was done on March 1, 1999, we looked for the symptoms that would prompt abdominal CT (Table 2 - 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 2.

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 non-recommended surveillance.

We evaluated overall use of the non-recommended 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 two-year surveillance period for the whole group. As 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 three months prior to the tests. Table 2 shows the symptoms we evaluated in the three months prior to a given test for each test type. We used a Cochran-Armitage test to evaluate trends in adherence or use of non-recommended 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 non-adjuvant chemotherapy (chemotherapy >6 months after definitive breast operation or more than one month after date of last adjuvant treatment), had a second breast resection for a diagnosis of cancer, or entered hospice. As the Kaplan-Meier analysis extended beyond two years, patients were also censored when they had no further follow-up (i.e. a patient diagnosed in 2004 would not have Medicare claims beyond 3 years from diagnosis).

All p-values were from two-sided tests. All analyses were performed with *SAS* version 9.2 (SAS Inc., Cary, NC, USA). Statistical significance was accepted at the $p < 0.05$ level.

RESULTS

Demographic, Tumor, and Primary Treatment Characteristics (Table 3)

We identified a total of 24,059 patients from the Texas Cancer Registry with the diagnosis of invasive ductal adenocarcinoma or ductal carcinoma in situ from 2001-2007. After applying the exclusion criteria shown in Figure 1, the final cohort was comprised of 8,598 patients.

The mean age of the cohort was 75.4 $\pm$ 6.6 years and the distribution by age group is shown in Table 3. 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, 37.3% had ductal carcinoma-in-situ. Of those with invasive cancer, 72.3% had localized disease, and 27.7% had regional disease. Tumor size, differentiation, and lymph node status are shown in Table 3. Breast-conserving therapy was performed in 41.3% of patients and mastectomy in 58.7% of patients. Only 62.6% of those who underwent breast conservation therapy also underwent adjuvant radiation therapy, and its use decreased with increasing age from 68.5% in patients less than 70 to 31.9% in patients 85 and older ($p < 0.0001$). 13.8% 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% of patients survived for the entire 2-year surveillance period.

Overall Guideline Adherence (Table 3)

Overall, only 55.3% of patients were guideline-adherent by our measure. Guideline adherence actually decreased over the study period from 57.5% in 2001 to 52.7% in 2007 ($p < 0.0001$).

Table 3 presents the unadjusted analysis of the factors associated with guideline adherence. Guideline adherence decreased as age increased, from 62.7% of patients younger than 70 to 30.5% in patients older than 85 ($p < 0.0001$). Guideline adherence decreased with increasing comorbidity ($p < 0.0001$) and increased in the higher education and income quartiles ($p < 0.0001$). Guideline adherence was highest for DCIS and decreased as stage advanced, with only 44.3% of patients with regional disease adhering to this composite measure ($p < 0.0001$). Patients undergoing breast-conserving therapy were more likely to undergo appropriate surveillance than those undergoing mastectomy ($p < 0.0001$). Likewise patients receiving adjuvant radiation after breast-conserving therapy and patients receiving chemotherapy were more likely to adhere to guidelines ($p < 0.0001$).

In a multivariate analysis (Table 4), younger age, non-Hispanic race, lower Charlson comorbidity score, breast conservation therapy, and regular visits with a medical oncologist or primary care physician (PCP) were independently associated with guideline adherence.

Use of Mammography and Physician Visits

While 78.9% of patients received at least one surveillance mammography in the two years after the start of the surveillance period, only 56.5% of patients received an annual mammogram for two consecutive years. When we evaluated the use of regular mammography alone, age, non-Hispanic race, lower Charlson comorbidity score, breast conservation therapy, and visits with a medical oncologist or PCP predicted annual mammography in the two years after diagnosis.

Figure 2A shows a Kaplan-Meier curve demonstrating the time to first mammography. 8,536 patients survived without recurrence to the beginning of the surveillance period. 1,837 patients were 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. 73.0% of patients underwent mammography within twelve months of the start of surveillance. However, of 5,713 patients who underwent at least one mammography, only 46.5% underwent repeat mammogram within a year of the first (Figure 2B). The median time from first to second mammogram was 12 months after the first mammogram, consistent with current recommendations.

Most patients (97.9%) had at least one physician visit within two years of the start of the surveillance period and nearly 90.0% of patients saw a physician twice a year in the two years after treatment. The majority of patients (58.2%) saw a PCP, 42.1% saw a medical oncologist, and 17.6% saw a surgeon at least twice a year for 2 years.

Use of Non-Recommended Tests for Distant and Locoregional Recurrence

Table 5 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 the 2-year time period and the percentage of tests without documented symptoms to prompt the test in the three months prior to the test. Cross-sectional imaging of the abdomen, chest, and head were used in over 20% of all patients in the 2-year surveillance period. PET/PET CT was used in 6.6% of patients and bone scans in 17.0%. The majority of all non-guideline recommended tests were obtained in the absence of symptoms. This finding was especially pronounced for PET/PET CT (99.4%) and bone scan (96.7%), which are typically used to identify occult distant metastases.

Time trends in the use of various non-recommended tests are shown in Figure 3. We identified a dramatic increase in PET/PET CT use from 1.9% in 2001 to 8.9% in 2007 ($p<0.0001$). Bone scan use decreased proportionately to the increase in PET/PET CT use, from 20.8% of patients in 2001 to only 13.0% in 2007 ($p<0.0001$); 60.3% 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 (Figure 3A). In patients with regional breast cancer, the use of non-recommended tests was higher. 37.1% underwent CT/MRI abdomen, 39.1% underwent CT/MRI chest, 24.3% underwent CT/MRI head, 15.1% underwent PET/PET CT, and 31.4% underwent bone scans. Use of non-recommended tests increased more dramatically over time in this subgroup with a statistically significant increase in PET/PET

CT from 4.0% in 2001 to 15.0% in 2007 ($p<0.0001$) over time. Bone scan use decreased from 40.8% in 2001 to 23.3% in 2007 ($p<0.0001$, Figure 3B).

Mammography use decreased over the study period from 81.0% of patients in 2001 to 75.2% of patients in 2007 ($p<0.0001$ 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 ($p<0.0001$). Of the 155 breast MRIs obtained, 91% were done in patients who also had mammography. Neither mammography nor MRI was performed in 15.5% of the overall cohort.

Overall, breast MRI was used more commonly in patients undergoing breast conservation than those who underwent mastectomy (3.1% vs. 1.3%, $p<0.0001$). For patients undergoing breast conservation therapy, the use of mammography decreased from 86.7% in 2001 to 82.2% of patients in 2007 ($p<0.0001$). The rise in MRI use was more dramatic in this population, from 0.3% of patients diagnosed in 2001 to 8.33% in 2007 ($p<0.0001$).

The use of breast MRI was higher in patients who were adherent to physician visit and mammography guidelines, while the use of cross-sectional imaging of the abdomen, chest, or head and PET/PET CT were higher in non-guideline adherent patients (Table 6). Bone scan use was equal between the two groups.

DISCUSSION

Following curative treatment for early stage breast cancer, only 55.3% of older women in Texas met the minimal post-treatment surveillance guidelines of two physician visits annually for 2 years and one mammogram per year for 2 years. While 90% of women saw a physician twice a year over the 2-year surveillance period, only 57% received two 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 noted a modest use of breast MRI (1.4%).²⁵ 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 to mammography for the detection of local recurrence.²⁶ However, the comparative effectiveness of the two 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 breast-conserving therapy. 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 breast-conserving therapy, 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, 27-31}, two 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 exam and mammography. Panageas et al demonstrated a 1.2% use of PET scans (1.2%) in treated breast cancer patients between 1998-2003.²⁵ We are the first to document a dramatic, nearly 5-fold, increase in the use of PET/PET-CT from 2001-2007 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 to conventional testing.³² Despite these findings, the cost-effectiveness of PET/PET CT in the post-treatment surveillance of breast cancer patients is unknown. Since 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 79.0% of patients in our cohort underwent a postoperative mammogram at any time in the two years following treatment, demonstrating little improvement since a 1997 study by Hillner et al²² in which 76.4% of women less than age 64 underwent mammography in the first 18 months after curative treatment. In addition, 15.5% of patients never received any imaging to detect local recurrence (mammography or breast MRI) consistent with a study by Schapira et al,³³ 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 breast-conserving therapy.^{33, 34} 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.³⁵

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 in 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 prior to 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 the above considerations. While 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 three months prior to 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 higher in younger women due 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 non-recommended 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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Cohort Selection

Figure 1.

Cohort Selection. We included only female residents of Texas aged 66 or older 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 one year before and two 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.

Figure 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 prior to any mammogram as they were no longer eligible for surveillance. Recurrence was considered to have occurred if patients started non-adjuvant chemotherapy (chemotherapy >6 months after definitive breast operation or more than one 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=1837. 73.0% of patients received a mammogram within first 12 months of surveillance. Median time to mammogram= 9 months. 5,714 patients received at least one mammogram. B) Time to second mammogram after receipt of first mammogram. N=6,699, censored, N=986. 46.5% of patients received a second mammogram in the year after their first. Median time from first to second mammogram=12 months.

Figure 3.

A. Trends in non-recommended surveillance testing in asymptomatic patients, 2001-2007. PET/PET CT use increased from 1.9% in 2001 to 15.9% in 2007 while bone scan use decreased from 20.8% in 2001 to 13.0% in 2007 ($p < 0.0001$). There was a non-statistically significant increase in the use of cross-sectional imaging of the abdomen, chest, and head over the study period.

B. Trends in non-recommended surveillance testing in asymptomatic patients with regional disease, 2001-2007. For patients with regional disease, the increase in PET/PET CT use was more dramatic, from 4.0% in 2001 to 18.9% in 2007. Bone scan decreased from 40.8% in 2001 to 23.3% in 2007 ($p < 0.0001$). Again, the use of cross-sectional imaging slightly increased during the study period.

Figure 4.

Trends in use of mammography and MRI over study period, 2001-2007. MRI use increased from 0.5% in 2001 to 7.0% in 2007 while mammography use decreased from 81.0% in 2001 to 75.2% in 2007 ($p < 0.0001$)

Current Post-Treatment Surveillance Recommendations for Treated Early Stage Breast Cancer

Table 1

	History and Physical	Mammography	Breast MRI	CT/MRI head, chest, abd	CXR	PET/PET CT	Bone scan
ASCO	Q3-6 months for years 1-3, q6-12 months for years 4-5, then annually	No earlier than 6mo after definitive treatment, then annually	NR	NR	NR	NR	NR
NCCN	Q4-6 months for 5 years, then annually	Starting 6-12mo 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

NR=not recommended, ND=not discussed.

Table 2

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

Table 3

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)	
Mean Age	75.4 +/- 6.6	NA	
Age			<0.0001
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			<0.0001
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			0.0004
Quartile 1	2121	1122 (52.9)	
Quartile 2	2118	1144 (54.0)	
Quartile 3	2124	1193 (56.2)	
Quartile 4	2122	1250 (58.9)	
Education			<0.0001
Quartile 1	2122	1079 (50.9)	
Quartile 2	2121	1146 (54.0)	
Quartile 3	2125	1236 (58.2)	
Quartile 4	2117	1248 (59.0)	
Charlson Comorbidity Index			<0.0001
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			<0.0001
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=6654)	21.3, +/- 21.1	NA	<0.0001
Differentiation			
Well/moderate	4,554 (53.0)	2,570 (56.4)	0.03

Factor	N (%)	Guideline Adherence N (%)	p-value
Poor	1,716 (20.0)	936 (54.6)	0.47
Nodal Status (N=1845)			<0.0001
Negative	2,369 (47.0)	1,612 (68.1)	
Positive	397 (7.9)	233 (58.7)	
Treatment Characteristics			
<u>Type of Operation</u>			<0.0001
Mastectomy	3,553 (41.3)	1,565 (44.1)	
Breast Conservation Therapy	5,045 (58.7)	3,191 (63.3)	
<u>Radiation after Breast Conservation</u>			
Adjuvant Radiation	3,191 (63.3)	2,299 (72.1)	<0.0001
No adjuvant radiation	1,854 (36.7)	843 (45.5)	
<u>Adjuvant Chemotherapy</u>			
Chemotherapy	1,186 (55.3)	616 (51.9)	0.01
No chemotherapy	3,842 (44.7)	570 (14.8)	

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

Table 4

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				
<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
75-79	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
Quartile 2	1.04	0.91-1.18	1.06	0.93-1.21
Quartile 3	1.15	1.00-1.32	1.16	1.01-1.32
Quartile 4	1.15	1.00-1.32	1.14	0.99-1.30
Charlson Comorbidity				
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 vs Mastectomy	2.04	1.85-2.25	2.06	1.87-2.28
Regular Physician Visits[*]				
Medical Oncologist (Yes vs. No)	2.59	2.34-2.87	2.39	2.16-2.64
PCP (Yes vs. 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

OR=odds ratio, CI=confidence interval, CIS=carcinoma in situ, BCT= breast conservation therapy, PCP=primary care physician

^{*}
2 visits a year for two years

Table 5

Non-Guideline Adherent Testing in Asymptomatic Patients

	Patients with at least one 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

Table 6

Non-Guideline Adherent Testing by Composite Guideline Adherence

Test	Total number of patients tested	Guideline adherent N=4756	Non-guideline adherent N=3842	P-value
		N (%) with test	N (%) with test	
Breast MRI	200	130 (2.7%)	70 (1.8%)	0.005
CT/MRI abd	2,277	1,158 (24.4%)	1,119 (29.1%)	<0.0001
CT/MRI chest	1,969	1,001 (21.1%)	968 (25.2%)	<0.0001
CT/MRI head	1,893	867 (18.2%)	1,026 (26.7%)	<0.0001
PET/PET CT	566	273 (5.7%)	293 (7.6%)	0.0005
Bone scan	1,462	805 (16.9%)	657 (17.1%)	0.83

CT=computed tomography, MRI=magnetic resonance imaging, PET= positron emission tomography