Original Article

Breast Biopsy Patterns and Outcomes in Surveillance, Epidemiology, and End Results–Medicare Data

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BACKGROUND: Despite known benefits to needle biopsy for suspicious breast lesions, variability in the use of this technique has been documented in practice. We sought to study the use of needle biopsy and open surgical biopsy in women with breast cancer, predictors of needle biopsy use, and the effect of biopsy choice on overall number of surgical procedures needed to treat breast cancer. **METHODS:** We analyzed Surveillance, Epidemiology, and End Results (SEER)-Medicare data for 45,542 women diagnosed between 1991 and 1999 with ductal carcinoma in situ and stage I-II breast cancer. By using diagnosis and procedure codes from 3 months before to 6 months after the SEER diagnosis, we classified the initial biopsy as needle or surgical. By using multivariate logistic regression, we identified patient and tumor characteristics associated with needle biopsy use, and estimated the association between initial biopsy type and likelihood for multiple breast surgeries. **RESULTS:** Needle biopsy was the initial procedure for 11,073 (24.3%) women. In multivariate analyses, needle biopsy use varied significantly by race, year of diagnosis, and tumor size. After controlling for patient and tumor characteristics, needle biopsy use was associated with a reduced likelihood of multiple breast surgeries (odds ratio, 0.35; 95% confidence interval, 0.34-0.37). **CONCLUSIONS:** Use of needle biopsy as the initial breast cancer procedure was more common among black women and those with larger tumors, and increased significantly over time. Providers should consider needle biopsy when clinically feasible as the initial breast procedure, because it may reduce the number of surgeries needed to treat breast cancer. **Cancer 2009;115:716–24. © 2009 American Cancer Society.**

KEY WORDS: breast, diagnostic techniques and procedures, outcome assessment (healthcare), health services research, SEER program, Medicare.

Patients with suspicious breast anomalies face several options to ascertain initial pathologic diagnosis. Historically, biopsies have been obtained by surgical excision. This procedure, however, causes women with benign breast disease the inconvenience and discomfort of surgery. In addition, if the margins of the initial excision are close or positive, patients must undergo additional breast surgical procedures. Needle

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biopsy techniques, including fine needle aspiration, core biopsy, and vacuum-assisted needle biopsy, are less invasive than surgical biopsies and accurately diagnose suspicious breast lesions.[1] Using needle biopsy to evaluate breast abnormalities may eliminate the need for surgery altogether when the lesion proves benign. When the needle biopsy shows cancer, subsequent cancer care may be coordinated, resulting in fewer surgical procedures overall. One breast center also reported significant cost savings associated with image-guided core biopsy compared with surgical biopsy.[2]

Despite these documented benefits, data suggest that the initial breast biopsy approach is quite variable within[3] and across practice settings (S.B.E., unpublished data). The purpose of this study was to evaluate the practice patterns and outcomes associated with needle biopsy and surgical excision in the diagnosis of breast cancer in a population-based cohort of women aged $\geq$65 years.

MATERIALS AND METHODS

Data Sources

We analyzed the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset to draw our analytic sample. The SEER-Medicare dataset is a collaborative project of the National Cancer Institute, the respective SEER registries, and the Centers for Medicare and Medicaid Services.[4] SEER-Medicare data link tumor registry information with claims for adults enrolled in Medicare; linkage methods have been described previously.[5,6] The data set captures roughly 97% of incident cancer cases,[7] and is especially rich with patients of African-American, Hispanic, Asian, and Hawaiian/Pacific Islander descent.[8] We analyzed tumor registry records and claims from the 11 registries that participated in SEER-Medicare between 1991 and 1999. All data were de-identified, and the study protocol was deemed exempt from institutional review board review. A signed data use agreement was executed by the senior author (C.C.E.).

Study Sample

The total number of breast cancer cases in the SEER-Medicare database between 1991 and 1999 was 154,926. Our sample included women with breast cancer diagnosed between January 1, 1991, and December 31, 1999, who had a claim for surgical breast excision within 6 months of their cancer diagnosis (n = 93,468). We restricted the sample to women who were diagnosed with stage I, stage II, or ductal carcinoma in situ (DCIS) before death, survived at least 6 months after diagnosis, had valid diagnosis dates, did not receive chemo- or radiotherapy before surgery, and had no history of cancer within the year preceding their breast-cancer surgery (n = 53,010). We excluded 5481 women diagnosed at age >85 years, 50 women diagnosed at age <65 years, and 1937 women who did not have continuous Part A and B Medicare coverage throughout the study period. The final analytic sample included 45,542 women. We used claims data for the time period of 3 months before breast cancer diagnosis, through 6 months after breast cancer diagnosis, to determine study eligibility.

Dependent Variables

By using International Classification of Diseases, Ninth Edition and Current Procedural Terminology codes, we identified all breast biopsies and surgical procedures that occurred during the same 9-month window. The list of diagnosis and procedure codes used in this study was developed in consultation with breast cancer clinical experts and appears in Table 1. In nearly a third of cases (14,582), women had claims for more than 1 biopsy procedure during the study period. When multiple biopsy procedure claims occurred on the same day, we considered this to be only 1 biopsy. When the same type of biopsy claim occurred on more than 1 day, we treated this as an additional biopsy procedure. We then measured the number of total biopsies and surgical procedures performed on the breast for each patient during the study period. We classified each patient as having received 1) a surgical biopsy before surgical excision if the surgical biopsy was their first or only biopsy procedure, 2) a needle biopsy before surgical excision if the needle biopsy was their first or only biopsy procedure, or 3) 1-step surgical excision if they did not have a needle or surgical biopsy reported. Women who had 2 or more surgical procedures during the study period were considered to have had multiple breast surgeries, and the initial breast biopsy procedure was not included in this count.

Table 1. Diagnosis and Procedure Codes Used in This Study

Variable	ICD-9 Diagnostic Codes	ICD-9 Procedure Codes	HCPCS	CPT	BETOS	CEN	DRG
Needle biopsy		85.11		19000, 19001, 19100, 88170, 19102, 19103, 76095, 76360, 76393, 76942, 88171			
Surgical biopsy		85.12, 85.20-85.25		19110, 19120, 19160, 19125, 19126, 76096, 76393, 76942			
Surgical breast procedures		85.12, 85.20, 85.21, 85.22, 85.23, 85.24, 85.25		1912x, 1913x, 1914x, 1915x, 1916x, 1917x, 1918x, 1919x, 1920x, 1921x, 1922x, 1923x, 1924x, 1925x, 19260, 19162			
Chemotherapy	E933.1, E930.7, V58.1, V66.2, V76.2	99.25	G0355, G0359, G0360, G0361, G0362, Q0083, Q0084, Q0085, J7150, J85xx, J86xx, J87xx, J8999, J9xxx	964xx, 965xx	O1D	0331, 0332, 0335	410
Radiation	V58.0, V66.1, V67.1	92.20-92.29	C1164, C1174, C1325, C1350, C1700, C1701, C1702, C1703, C1704, C1705, C1706, C1707, C1708, C1709, C1710, C1711, C1712, C1715, C1716, C1717, C1718, C1719, C1720, C1728, C1790, C1791, C1792, C1793, C1794, C1795, C1796, C1797, C1798, C1799, C1800, C1801, C1802, C1803, C1804, C1805, C1806, C2300, C2616, C2622, C2633, G0173, G0174, G0178, G0242, G0243, G0256, G0261, G0273, G0274, G0338, G0339, G0340, Q3001	61793, 77xxx, 79030, 79035, 79100, 79200, 79300, 79400, 79420, 79440, 79900, 79999	P7A	0330, 0333, 0339, 0973	409

ICD-9 indicates International Classification of Diseases, Ninth Revision; HCPCS, Health Care Procedure Coding System; CPT, Current Procedural Terminology; BETOS, Berenson-Eggers Type of Service; CEN, Revenue Center Code; DRG, Diagnosis-Related Group.

Independent Variables

Patient characteristics included age at diagnosis, race (white, black, or other, nonwhite), Hispanic descent, marital status, and presence of comorbidities, as measured by the Klabunde modification of the Charlson Comorbidity Index.[9,10] From the SEER registry data, we measured the following tumor characteristics: stage (DCIS, I, II), tumor size at diagnosis (<2 cm, 2-5 cm, >5 cm, not recorded), histology (ductal, lobular, other), and grade (1, 2, 3, other/unknown). We also obtained the geographic region, urban or rural residence, prior receipt of state financial assistance, and year of diagnosis from the SEER data. Prior care in a teaching hospital was measured using Medicare inpatient claims files. Teaching hospital care was not necessarily associated with the biopsy or surgical procedures analyzed during the study period.

Statistical Analysis

We examined differences in the frequencies of the initial biopsy procedures used for the different patient groups (as defined by sociodemographic, clinical, geographic, and other characteristics). The frequency of the breast biopsy procedures over time was examined using the Cochran-Armitage test for trend. We estimated the likelihood of needle biopsy as the initial biopsy procedure using a logistic regression model that incorporated patient, tumor, and system characteristics as the independent variables. As an initial examination, we compared the total number of surgical breast procedures performed during the study period based on type of initial biopsy with 1-way analysis of variance (ANOVA). Post hoc tests were calculated using the Gabriel statistic[11] because of uneven group sizes. Finally, we used logistic regression to estimate the likelihood of multiple breast surgeries during the study period. The initial model for multiple surgeries included only patient and tumor characteristics. After retaining significant variables, we added type of initial breast biopsy as a dichotomous predictor variable.

Sensitivity analyses

We measured type of initial breast biopsy as both categorical (needle biopsy, surgical biopsy, or no biopsy) and dichotomous (initial needle biopsy or not). No significant change in parameter estimates was observed when we compared an ordered logit model for the categorical measure versus a logistic regression model for the dichotomous measure. We also modified our definition of multiple breast surgeries to include 3 or more surgical breast procedures during the study period. When we replicated our logistic regression model estimating the likelihood of 3 or more breast surgeries, our findings did not change appreciably.

SAS version 9.1 (SAS Institute Inc., Cary, NC) was used for all analyses. For chi-square and ANOVA results, P values less than .05 were considered statistically significant. Parameter estimates from logistic regression models were expressed as odds ratios, and 95% confidence intervals (CIs) were calculated.

RESULTS

Baseline Characteristics

Table 2 shows patient and tumor characteristics for the sample by type of initial breast biopsy. A large number of patients (n = 16,455) did not have prior inpatient claims to calculate the modified Charlson comorbidity score, or to measure history of care in a teaching hospital. We retained these patients and added a category to our variable to reflect lack of claims data. The distribution of patients by year ranged from 3460 (7.6%) in 1991 to 5504 (12.1%) in 1992 (results not shown). The mean age at diagnosis was 74.2 years (standard deviation [SD], 5.3). Initial needle biopsy was less common for black women and Hispanic women. The distribution of patients varied significantly by geographic region: the largest number of cases was from the West, with subsequent higher rates of needle biopsy. Initial surgical biopsy was more common for women with stage II disease, tumors <2 cm in size, and higher grades. There was no relationship between type of initial biopsy and number of comorbid conditions, history of care in a teaching hospital, or history of state assistance.

Biopsy Trends and Predictors

The use of needle biopsy as the initial procedure nearly doubled over the study period from 16.5% in 1992 to 30.9% in 1999, and as expected the use of surgical biopsies decreased over time (Fig. 1). Cochran-Armitage tests for trend were significant (z test, −24.69; both $P <$ .0001).

Table 2. Characteristics by Initial Breast Biopsy Technique

	Needle Biopsy (n=11,073)		Non-needle Biopsy (n=34,469)		*P*
	Mean	SD	Mean	SD	
Patient characteristics					
Age at diagnosis, y	74.5	5.3	74.1	5.3	<.001
	No.	%	No.	%	
Race					<.001
White	9970	90.0	31,290	90.8	
Black	544	4.9	1802	5.2	
Other, non-white	559	5.1	1377	4.0	
Hispanic	319	2.9	1165	3.4	.01
Married at diagnosis	5100	46.1	16,349	47.4	.01
Comorbidities					.16
0	4278	38.6	13,334	38.7	
1	2002	17.8	6111	17.7	
2	478	4.2	1444	4.2	
≥3	383	3.2	1057	3.1	
Missing	3932	36.1	12,523	36.3	
Tumor characteristics					
Tumor stage					<.001
DCIS	1248	11.3	5449	15.8	
Stage 1	5149	46.5	19,242	55.8	
Stage 2	4676	42.2	9778	28.4	
Tumor size					<.001
<2 cm	6801	61.4	25,351	73.6	
2-5 cm	3567	32.2	6556	19.0	
>5 cm	192	1.7	400	1.2	
Unknown	513	4.6	2162	6.3	
Histology					.01
Ductal	7938	71.7	24,493	71.1	
Lobular	1096	9.9	3187	3.3	
Other	2039	18.4	6789	19.7	
Grade					<.001
1	1689	15.3	5457	15.8	
2	3978	35.9	11,349	32.9	
3	2836	25.6	6790	19.7	
Other/unknown	2570	23.2	10,873	31.5	
System characteristics					
Geographic region					<.001
Northeast	1441	13.0	5255	15.3	
South	733	6.6	1954	5.7	
Midwest	2911	26.3	10,749	31.2	
West	5988	54.1	16,511	47.9	
Urban residence	10,102	91.2	31,051	90.1	<.001
History of state assistance	1523	13.8	4653	13.5	.50
Received care in teaching hospital					.29
No	1051	9.5	3240	9.4	
Yes	6090	55.0	18,706	54.3	
Missing	3932	35.5	12,523	36.3	

SD indicates standard deviation; DCIS, ductal carcinoma in situ.
The non-needle biopsy group included 1351 patients with one-step surgery (surgical breast excision without claims for biopsy procedures). The West region included Hawaii.

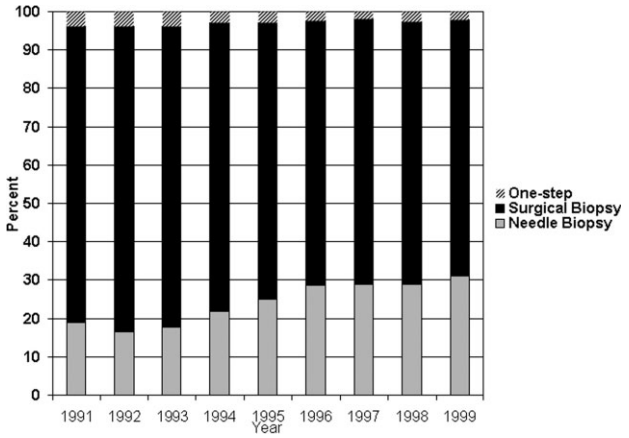

FIGURE 1. Initial breast biopsy technique over time is shown. One-step surgery is defined as surgical excision of breast tissue without a claim for needle or surgical biopsy. Cochran-Armitage test for trend is significant (z test, −24.69; both $P < .0001$).

Table 3 shows the results of a multivariate logistic regression model estimating the likelihood of initial needle biopsy. After controlling for other variables, women who were black were less likely to receive needle biopsy then white women (odds ratio, 0.90; 95% CI, 0.81-0.99). Compared with white women, women whose race was not black or white were more likely to receive needle biopsy (odds ratio, 1.12; 95% CI, 1.01-1.25). The majority of women in the "other" race and ethnicity category are of Asian/Pacific Islander descent; these women are largely concentrated in the West/Pacific region. Hispanic ethnicity is a separate variable from race in the data set. Hispanic women (odds ratio, 0.72; 95% CI, 0.63-0.82) were less likely to receive needle biopsy than non-Hispanics. Women with tumors of lower stage, smaller size, and lower grade were less likely to receive initial needle biopsy. Women in the Northeast (odds ratio, 0.74; 95% CI, 0.69-0.79) and Midwest (odds ratio, 0.76; 95% CI, 0.72-0.80) regions were significantly less likely to receive initial needle biopsy than women in the West. Year of diagnosis remained a significant predictor of initial needle biopsy on multivariate analysis.

Biopsy Technique and Multiple Breast Surgeries

Table 4 shows the mean number of breast surgical procedures based on the type of initial breast biopsy. The average number of breast surgical procedures was 1.75 (SD, 0.70; range, 1-7 procedures), but significant differences were found by type of initial breast biopsy. Women who had no biopsy and went straight to mastectomy or lumpectomy had the lowest number of surgical procedures (mean, 1.24; SD, 0.47; range, 1-4). Women who had an initial needle biopsy before surgical excision had the next lowest number of surgical procedures (mean, 1.50; SD, 0.65; range, 1-6), followed by women who had surgical biopsy before surgical excision (mean, 1.86; SD, 0.69; range, 1-7). The difference in surgical procedures across groups was significant ($F = 1030.41$; 4 df; $P < .01$). From post hoc tests performed using a 1-way ANOVA model, the differences in the average number of procedures between the groups was also statistically significant ($P < .01$).

Table 3. Patient, Tumor, and System Characteristics Associated With Receipt of Needle Biopsy as Initial Technique (N = 45,542)

	Odds Ratio	95% CI	
Patient characteristics			
Age at diagnosis	1.01	1.01	1.01
Race			
Black	0.90	0.81	0.99
Other, non-white	1.12	1.01	1.25
White	—	—	—
Hispanic	0.72	0.63	0.82
Tumor characteristics			
Stage			
Stage 0 (DCIS)	0.66	0.60	0.73
Stage 1	0.80	0.75	0.87
Stage 2	—	—	—
Tumor size			
<2 cm	0.65	0.54	0.77
2-5 cm	1.07	0.90	1.28
Missing tumor size	0.72	0.58	0.88
>5 cm	—	—	—
Grade			
Other/unknown	0.77	0.72	0.82
Grade 1	0.84	0.79	0.91
Grade 2	0.92	0.86	0.97
Grade 3	—	—	—
System characteristics			
Region			
Northeast	0.74	0.69	0.79
South	1.04	0.95	1.14
Midwest	0.76	0.72	0.80
West	—	—	—
Year of diagnosis	1.11	1.10	1.12

CI indicates confidence interval; DCIS, ductal carcinoma in situ.
Likelihood ratio, chi-square, 1884.86; 16 df; $P < .0001$; c-statistic: 0.64.
Parsimonious model is reported; independent variables not significant in univariate or multivariate analyses have been removed.

Table 4. Surgical Breast Procedures by Initial Biopsy Technique*

Initial Breast Biopsy Technique	No.	Mean of Surgical Procedures†	SD	Range
One-step surgery	1351	1.24	0.47	1-4
Needle	11,073	1.50	0.65	1-6
Surgical	33,118	1.86	0.69	1-7
Total	45,542	1.75	0.70	1-7

SD indicates standard deviation.
* One-step surgery is defined as surgical excision of breast tissue without a claim for needle or surgical biopsy. Differences in means are significant in a one-way analysis of variance, $F = 1577.10$; 2 df; $P < .0001$.
† Post hoc test for differences across all categories is statistically significant at $P < .01$.

Table 5. Predictors of Multiple Breast Surgeries (N = 45,542)*

Parameter	OR	95% CI
Initial needle biopsy	0.35	0.34-0.37
Patient characteristics		
Age at diagnosis	0.95	0.95-0.96
Tumor characteristics		
Stage		
Stage 0	0.84	0.77-0.91
Stage 1	1.10	1.03-1.18
Stage 2	—	—
Tumor size		
<2 cm	1.33	1.12-1.59
2-5 cm	0.81	0.68-0.96
Missing	1.54	1.26-1.87
>5 cm	—	—
Histology		
Ductal	0.85	0.80-0.89
Lobular	0.94	0.87-1.02
Other	—	—
Grade		
Other/unknown	1.01	0.95-1.07
Grade 1	0.99	0.92-1.05
Grade 2	0.97	0.92-1.03
Grade 3	—	—
System characteristics		
Geographic region		
Northeast	0.81	0.76-0.86
South	1.05	0.96-1.14
Midwest	1.13	1.07-1.18
West	—	—
Year of diagnosis	1.03	1.02-1.04
Received care in teaching hospital		
No	0.89	0.83-0.95
Yes	0.97	0.93-1.02
Missing	—	—

OR indicates odds ratio; CI, confidence interval.
* Likelihood ratio, chi-square, 3867.1; 18 df; $P < .0001$; c-statistic, 0.66. Parsimonious model is reported; independent variables not significant in univariate or multivariate analyses have been removed.

Table 5 shows the results of a logistic regression model to predict multiple breast surgeries, defined as 2 or more surgical procedures on the breast during the study period (excluding the initial breast biopsy procedure). After controlling for other significant predictors, having an initial needle biopsy was significantly associated with having a decreased likelihood of multiple breast surgeries during the study period (odds ratio, 0.35; 95% CI, 0.34-37). Additional characteristics associated with a decreased likelihood of multiple surgeries were age (odds ratio, 0.95; 95% CI, 0.95-0.96), having DCIS versus a stage II cancer (odds ratio, 0.84; 95% CI, 0.77-0.91), and having ductal versus other/unspecified histology (odds ratio, 0.85; 95% CI, 0.80-0.89). When compared with patients with tumors >5 cm, patients with tumors <2 cm had increased odds of multiple surgeries (odds ratio, 1.33; 95% CI, 1.12-1.59), whereas patients with tumors between 2 and 5 cm had significantly lower odds of multiple surgeries (odds ratio, 0.81; 95% CI, 0.68-0.96). Compared with patients from the West, women residing in the Northeast (odds ratio, 0.81; 95% CI, 0.76-0.86) and Midwest (odds ratio, 1.13; 95% CI, 1.07-1.18) regions had significantly different likelihoods for multiple surgeries. Additional significant effects on multiple surgeries were found by year of diagnosis (odds ratio, 1.03; 95% CI, 1.02-1.04) and for patients with no prior history of care in a teaching hospital (odds ratio, 0.89; 95% CI, 0.83-0.95).

DISCUSSION

We found that having an initial needle biopsy was associated with a significant decrease in the likelihood of having multiple surgical procedures on the breast, even after

controlling for several patient and tumor characteristics. Not surprisingly, needle biopsy use appeared to increase over time. This may have been a reflection of increasing confidence in clinician skill or increasing availability of experienced providers. However, by the end of our study a majority of women (69%) still did not have an initial needle biopsy. Moreover, we found significant variations in the use of needle biopsy by race/ethnicity, geography, and tumor characteristics. Compared with residents of the West, women in the Northeast were significantly less likely to receive both needle biopsy and multiple surgeries, whereas women residing in the South were more likely to have both needle biopsy and multiple surgeries. It is clear that geographic variations are present in breast care, and are worthy of continued study. Specifically, it is interesting to consider why providers in the Midwest are more likely to re-excise, although they also perform needle biopsy at a high rate. Black and Hispanic women were less likely to receive needle biopsy, but there were no differences in the likelihood of multiple surgeries by race. It is noteworthy that both tumor size and stage were associated with initial biopsy technique and multiple surgeries, whereas tumor grade was only associated with surgeries.

There are some limitations inherent in analyses of registry and claims data. For example, only limited data on the characteristics of providers and facilities are available. Additional data might reveal more detailed explanations for the observed variations in initial biopsy type and number of surgeries. For example, availability of experienced providers and tools needed to perform a needle biopsy may have varied significantly from 1 location to another. Because of our reliance on Medicare data, we are unable to draw any conclusions regarding Medicare enrollees participating in health maintenance organization plans, or the population of women aged <65 years. We are not able to measure the context of the clinical encounters that may impact the decision to have a needle or surgical biopsy. Correlation of our findings in settings with documentation of clinician and patient deliberations would be helpful. However, the multiple years and geographic regions represented in our data add strength to our findings and conclusions.

These analyses are restricted to studying surgical procedures on the breast, and additional consideration of axillary procedures may be important. Women who receive initial needle biopsy may be more likely to proceed to simultaneous breast and axillary surgery. For patients who receive surgical biopsy and have negative margins, additional axillary surgery is most likely required. As such, we would not expect the findings reported here to change dramatically. Another limitation is our reliance on data through 1999, because this was when the core needle biopsy technique was coming into wider acceptance. Because of delays in availability of SEER-Medicare data, we were not able to assess the proportion of women with cancer diagnosed by needle biopsy in more recent years. On the basis of individual practice reports, it seems likely that a higher proportion of women have needle biopsy now than what was observed in 1999. For example, about 70% of women with breast cancer treated at National Comprehensive Cancer Network centers from 2002 to 2006 had a needle biopsy performed (S.B.E., unpublished data). Regardless, it seems likely that variation in use of initial needle biopsy by geographic and sociodemographic features persists today.

Our study joins a long list of publications that document disparities in breast cancer treatment by race, age, geography, and other patient characteristics. Most recently, a study found that black women, older women, and women living in nonmetropolitan areas were less likely to receive radiotherapy after breast conservation surgery.[12] Significant differences by geography and race were found in a study comparing breast conversation therapy versus mastectomy.[13,14] Black women are also less likely to receive adjuvant radiotherapy for early stage breast cancer.[15] Our findings suggest that disparities in breast care occur even earlier in the diagnostic process.

The National Cancer Policy Board[16] and others[17] have identified the quality of cancer care, especially breast cancer, as uneven in the United States. The Institute of Medicine's Quality Chasm[18] report concludes that providers should strive to deliver care that is effective, patient-centered, and equitable. Using needle biopsy rather than surgical biopsy to evaluate suspicious breast abnormalities may lead to a decrease in the need for multiple breast surgeries, and as a result could reduce complications, improve timeliness of care, and most importantly improve patient satisfaction and quality of life. Clinicians should consider whether all patients eligible for needle biopsy in their practice are provided with this option before proceeding with further diagnostic or therapeutic interventions. Interventions aimed at increasing the availability

and acceptance of this technique and efforts to standardize biopsy techniques may improve quality of care for women with breast cancer.

Conflict of Interest Disclosures

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This study used the linked SEER-Medicare database, and the authors acknowledge the efforts of the respective agencies in creating the database. The interpretation and reporting of these data are the sole responsibility of the authors. At the time of the study, the corresponding author (C.R.F.) was research fellow, Center for Outcomes and Policy Research, Dana-Farber Cancer Institute, and Department of Society, Human Development, and Health, Harvard School of Public Health.

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