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State Variation in the Receipt of a Contralateral Prophylactic Mastectomy Among Women Who Received a Diagnosis of Invasive Unilateral Early-Stage Breast Cancer in the United States, 2004-2012

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Supplemental content

IMPORTANCE The use of contralateral prophylactic mastectomies (CPMs) among patients with invasive unilateral breast cancer has increased substantially during the past decade in the United States despite the lack of evidence for survival benefit. However, whether this trend varies by state or whether it is correlated with changes in proportions of reconstructive surgery among these patients is unclear.

OBJECTIVE To determine state variation in the temporal trend and in the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery.

DESIGN, SETTING, AND PARTICIPANTS A retrospective cohort study of 1.2 million women 20 years of age or older diagnosed with invasive unilateral early-stage breast cancer and treated with surgery from January 1, 2004, through December 31, 2012, in 45 states and the District of Columbia as compiled by the North American Association of Central Cancer Registries. Data analysis was performed from August 1, 2015, to August 31, 2016.

EXPOSURE Contralateral prophylactic mastectomy.

MAIN OUTCOMES AND MEASURES Temporal changes in the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery by age and state, overall and in relation to changes in the proportions of those who underwent reconstructive surgery.

RESULTS Among the 1 224 947 women with early-stage breast cancer treated with surgery, the proportion who underwent a CPM nationally increased between 2004 and 2012 from 3.6% (4013 of 113 001) to 10.4% (12 890 of 124 231) for those 45 years or older and from 10.5% (1879 of 17 862) to 33.3% (5237 of 15 745) for those aged 20 to 44 years. The increase was evident in all states, although the magnitude of the increase varied substantially across states. For example, among women 20 to 44 years of age, the proportion who underwent a CPM from 2004-2006 to 2010-2012 increased from 14.9% (317 of 2121) to 24.8% (436 of 1755) (prevalence ratio [PR], 1.66; 95% CI, 1.46-1.89) in New Jersey compared with an increase from 9.8% (162 of 1657) to 32.2% (495 of 1538) (PR, 3.29; 95% CI, 2.80-3.88) in Virginia. In this age group, CPM proportions for the period from 2010 to 2012 were over 42% in the contiguous states of Nebraska, Missouri, Colorado, Iowa, and South Dakota. From 2004 to 2012, the proportion of reconstructive surgical procedures among women aged 20 to 44 years who were diagnosed with early-stage breast cancer and received a CPM increased in many states; however, it did not correlate with the proportion of women who received a CPM.

CONCLUSIONS AND RELEVANCE The increase in the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery varied substantially across states. Notably, in 5 contiguous Midwest states, nearly half of young women with invasive early-stage breast cancer underwent a CPM from 2010 to 2012. Future studies should examine the reasons for the geographic variation and increasing trend in the use of CPMs.

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Breast cancer is the most commonly diagnosed cancer and the second leading cause of cancer death among women in the United States.[1] Treatment for breast cancer varies by hormone and human epidermal growth factor receptor 2 status, stage, and histologic type and may include a combination of surgery, chemotherapy, hormonal therapy, and radiotherapy. Several studies in the United States have reported a marked increase in the use of contralateral prophylactic mastectomies (CPMs) for women who receive a diagnosis of early-stage unilateral breast cancer, particularly for patients younger than 45 years of age,[2-4] despite a lack of evidence for survival benefit.[5-9] The reasons for this increasing pattern are unclear but are thought to include the fear of developing a second breast cancer and the desire for breast symmetry following reconstructive surgery.[10-12]

Two previous studies based on the Surveillance, Epidemiology, and End Results (SEER) database[13] and the National Cancer Data Base (NCDB)[2] reported regional variation in the proportions of CPMs. However, these studies were limited because the SEER database (a population-based cancer registry) covers only 28% of the US population[14] and because the NCDB (a hospital-based cancer registry) coverage in some states (eg, 27% in Arizona) is too low to provide representative state-specific estimates.[15,16]

We examined temporal trends by state and age in the proportion of patients who received CPMs among women diagnosed with invasive unilateral early-stage breast cancer and treated with surgery from 2004 through 2012. We used nationwide population-based incidence data as collected by the SEER program and the National Program of Cancer Registries and compiled by the North American Association of Central Cancer Registries (NAACCR).[17] Using these data, we also examined whether the temporal changes in the proportion of women receiving a CPM by state were correlated with changes in the proportion of women undergoing reconstructive surgery following a CPM.

Key Points

Question Does the proportion of contralateral prophylactic mastectomies vary by state?

Findings In this cohort study of more than 1.2 million women who received a diagnosis of invasive unilateral early-stage breast cancer treated with surgery, the proportion of contralateral prophylactic mastectomies varied substantially by state. The proportion among women 20 to 44 years of age during the period from 2010 to 2012 ranged from 15.7% in Hawaii to 42.8% to 48.5% in 5 contiguous Midwestern states.

Meaning Patients should be educated about the benefit and harm of a contralateral prophylactic mastectomy for informed decision making.

Methods

Data Source and Variables

Demographic and clinical information for women 20 years of age or older who received a diagnosis of primary invasive unilateral breast cancer between January 1, 2004, and December 31, 2012 (n = 1 404 411), was obtained from the NAACCR database for the District of Columbia and all states except for the nonconsenting states of Illinois, Maryland, and Vermont and owing to a lack of readily available data in Kansas and Minnesota. This project was reviewed and approved by the NAACCR institutional review board and was exempt from informed consent of individual study participants because it used only de-identified patient data.

Surgical interventions were categorized as breast-conserving surgery (BCS), unilateral mastectomy (UM) with or without reconstruction, or CPM with or without reconstruction. Stage was categorized as local or regional according to the 2000 *SEER Summary Staging Manual*.[18] Patients not undergoing surgery (123 007 [8.8%]) and those with unknown or unclear surgical procedures (21 728 [1.5%]) were excluded from analyses, as were patients with distant (27 444 [2.0%]) or unknown stage (7285 [0.5%]), resulting in a final sample size of 1 224 947 patients.

Tumor size was grouped into 3 categories: less than 2 cm, 2 to 4.9 cm, and 5 to 20 cm; cases with a likely erroneously recorded tumor size of more than 20 cm (n = 1262) were classified as missing tumor size. Tumor grade was categorized as well differentiated, moderately differentiated, poorly differentiated, or undifferentiated. Race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, non-Hispanic other, and Hispanic based on self-identified race and Hispanic origin.[19] Age at diagnosis was categorized in 10-year age groups to compare CPMs with other surgical procedures at the national level. To investigate CPM trends temporally and geographically, age at diagnosis was collapsed into 2 categories: 20 to 44 years of age and 45 years of age or older, with a particular emphasis on women 20 to 44 years of age, for whom a CPM is more common.

Statistical Analysis

Statistical analysis was performed from August 1, 2015, to August 31, 2016. For each state, we calculated the proportion of patients undergoing a CPM among all women with early-stage unilateral breast cancer treated with surgery (BCS, UM, or CPM) by age (20-44 vs ≥45 years) and year of diagnosis averaged across 3 years (2004-2006, 2007-2009, and 2010-2012). We aggregated data across 3 years so that all state-specific estimates were based on at least 10 cases. Temporal trends in the proportion of patients undergoing a CPM between the first (2004-2006) and last (2010-2012) 3-year period were calculated as a prevalence ratio (PR) with asymptotic 95% CIs.[20] To illustrate variation by state, maps of the United States were created in ArcMap, version 10.3.1 (ESRI). To show changes in the temporal trend over time for each of the 2 age groups (20-44 and ≥45 years), we used a joinpoint model, with a maximum of 1 joinpoint allowed. A log-transformed model was used to approximate a fixed annual percent change (APC) to account for the skewed distribution over time. In this method, the APC is calculated by fitting a least-squares regression line to the natural logarithm of the proportion, using year of diagnosis as the regressor variable.[21] In the presence of a significant joinpoint, 2 values for APC were calculated, preceding and following the identified joinpoint.

Multivariable analysis was conducted using binary logistic regression, in which the outcome variable was CPM vs other surgery (UM or BCS). A second logistic regression model was fitted restricted only to patients who underwent a mastectomy (CPM vs UM). For both of these analyses, a single model was fit to the data, and the results were reported as odds ratios adjusted for the effect of the other covariates and 95% CIs. Statistical analyses were performed using SAS, version 9.4 (SAS Institute Inc), and joinpoint analysis was performed using Joinpoint Regression Program, version 4.2.0.2 (NCI). $P = .05$ (2-tailed) was considered significant.

We also examined state-specific trends in reconstructive surgery by age (20-44 years and ≥45 years) and year of diagnosis for women who underwent a CPM or a UM. We correlated the proportion of CPMs among women 20 to 44 years of age with early-stage unilateral breast cancer treated with surgery during the most recent period (2010-2012) with the proportion of reconstructive surgical procedures among women who were diagnosed with early-stage breast cancer and received a CPM by state, as well as the relative percent change in the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery between 2004-2006 and 2010-2012 with the corresponding relative percent change in reconstructive surgery, using the Pearson correlation coefficient. We repeated these correlation analyses with proportions of reconstructive surgical procedures among women who were diagnosed with early-stage breast cancer and received a mastectomy (either a UM or a CPM).

Results

Of 1 224 947 patients with unilateral early-stage breast cancer who underwent surgery between 2004 and 2012 and met the inclusion criteria, 715 914 (58.4%) had BCS, 402 434 (32.9%) had a UM, and 106 599 (8.7%) had a CPM (**Table 1**). Nationally, the proportion of patients undergoing a CPM monotonically increased with younger age from 2.4% (7891 of 330 698) for those 70 years or older to 29.3% (1896 of 6464) for those 20 to 29 years of age and with later years of diagnosis from 5.1% (20 037 of 391 393) in 2004-2006 to 11.9% (49 592 of 416 030) in 2010-2012.

Multivariable analysis also showed that the odds of undergoing a CPM compared with other surgery (BCS or UM) were significantly higher for younger patients (eTable 1 in the Supplement). In binary logistic regression, the odds of undergoing a CPM compared with other surgery ranged from 2.5 (95% CI, 2.5-2.6) for patients 60 to 69 years of age to 18.6 (95% CI, 17.4-19.8) for patients 20 to 29 years of age compared with patients 70 years of age or older. In addition, the odds of undergoing a CPM compared with other surgical procedures were significantly higher for patients who received a diagnosis of node-positive regional stage disease than for patients who received a diagnosis of local stage disease and were higher for patients with lobular carcinoma than for patients with ductal carcinoma, as well as for white vs nonwhite patients and for privately insured vs uninsured or non-privately insured patients. In contrast, in analyses restricted to patients receiving a mastectomy, the odds of undergoing a CPM compared with a UM were lower for patients who received a diagnosis of regional stage disease than for patients who received a diagnosis of local stage disease and were lower for patients with large tumors (≥2 cm) than for patients with small tumors (<2 cm) (eTable 1 in the Supplement).

Figure 1 depicts the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery by each year of diagnosis from 2004 to 2012 for all patients (≥20 years) and for the collapsed age categories (20-44 and ≥45 years) nationally. The proportion nationally increased between 2004 and 2012 from 3.6% (4013 of 113 001) to 10.4% (12 890 of 124 231) for those 45 years or older and from 10.5% (1879 of 17 862) to 33.3% (5237 of 1574) for those aged 20 to 44 years. Joinpoint analysis of the temporal trend showed that the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery significantly increased by an APC of 22% per year from 2004 through 2008 and by 11% per year from 2008 through 2012 for women 20 to 44 years of age ($P < .05$). Similarly, APCs preceding and following the 2008 joinpoint in women 45 years of age or older were 22% and 10%, respectively ($P < .05$) (eFigure in the Supplement).

The proportions of CPMs among women 20 to 44 years of age with early-stage unilateral breast cancer treated with surgery by state and year of diagnosis are presented in **Table 2** (eTable 2 in the Supplement contains data from 2007 to 2009). From 2004-2006 to 2010-2012, the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery significantly increased in every state except Wyoming, with the magnitude of the increase varying by state. For example, between 2004-2006 and 2010-2012, the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery increased by about 3-fold in Virginia (PR, 3.29; 95% CI, 2.80-3.88) and Kentucky (PR, 3.03; 95% CI, 2.51-3.66), while it increased less than 2-fold in several states, such as New Jersey (PR, 1.66; 95% CI, 1.46-1.89). During the most recent time period (2010-2012), the proportion of CPMs among women with early-stage unilateral breast cancer treated with surgery substantially varied by state, from about 15% in Hawaii and the District of Columbia to greater than 42% in South Dakota, Iowa, Colorado, Missouri, and Nebraska (Table 2 and **Figure 2**). South Dakota also registered the highest proportion of women who underwent a CPM during the period from 2004 to 2006 (29.9% [41 of 137]), and West Virginia (6.0% [19 of 319]) and Utah (5.8% [21 of 364]) registered the lowest proportions.

The corresponding proportions of CPMs among women 45 years or older with early-stage unilateral breast cancer treated with surgery are presented in eTable 3 in the Supplement and Figure 2. Similar to the results seen among the younger age group, the proportion of CPMs among women 45 years or older with early-stage unilateral breast cancer treated with surgery significantly increased from 2004-2006 to 2010-2012 in all states except the District of Columbia, where the proportion of CPMs among women 45 years or older with early-stage unilateral breast cancer treated with surgery remained unchanged (2004-2006, 3.3% [25 of 759]; 2010-2012, 3.2% [26 of 810]). Prevalence ratios ranged from about 1.7 in South Dakota and Colorado to greater than 3.5 in Missouri, West

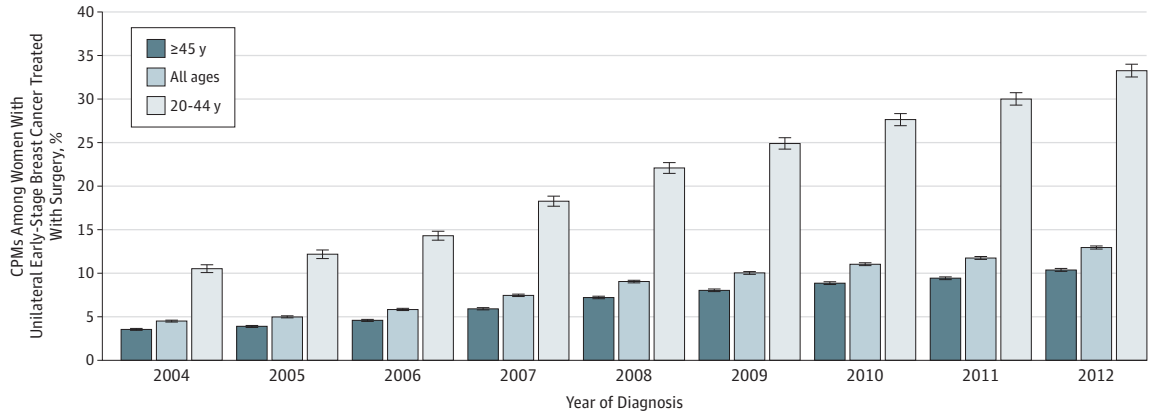
Table 1. Patient Demographic and Tumor Characteristics

Characteristic	Patients, No. (%)			
	Total (N = 1 224 947)	Breast-Conserving Surgery (n = 715 914)	Unilateral Mastectomy (n = 402 434)	Bilateral Mastectomy (n = 106 599)
Age at diagnosis, y				
20-29	6464	2285 (35.3)	2283 (35.3)	1896 (29.3)
30-39	57 458	22 897 (39.8)	20 049 (34.9)	14 512 (25.3)
40-49	221 730	115 167 (51.9)	72 165 (32.5)	34 398 (15.5)
50-59	305 252	182 283 (59.7)	93 517 (30.6)	29 452 (9.6)
60-69	303 345	192 249 (63.4)	92 646 (30.5)	18 450 (6.1)
≥70	330 698	201 033 (60.8)	121 774 (36.8)	7891 (2.4)
Year of diagnosis				
2004-2006	391 393	232 877 (59.5)	138 479 (35.4)	20 037 (5.1)
2007-2009	417 524	241 924 (57.9)	138 630 (33.2)	36 970 (8.9)
2010-2012	416 030	241 113 (58.0)	125 325 (30.1)	49 592 (11.9)
Summary stage				
L	816 468	552 349 (67.7)	205 083 (25.1)	59 036 (7.2)
RE	25 615	11 263 (44.0)	12 589 (49.1)	1763 (6.9)
RN	331 231	143 348 (43.3)	148 154 (44.7)	39 729 (12.0)
RE+RN	51 633	8954 (17.3)	36 608 (70.9)	6071 (11.8)
Histologic type				
Ductal	1 033 374	614 682 (59.5)	330 583 (32.0)	88 109 (8.5)
Lobular	106 550	51 229 (48.1)	42 458 (39.8)	12 863 (12.1)
Other	85 023	50 003 (58.8)	29 393 (34.6)	5627 (6.6)
Tumor grade				
Well differentiated	256 944	178 579 (69.5)	61 423 (23.9)	16 942 (6.6)
Moderately differentiated	493 307	291 711 (59.1)	159 939 (32.4)	41 657 (8.4)
Poorly differentiated	393 520	202 315 (51.4)	150 605 (38.3)	40 600 (10.3)
Undifferentiated	8497	4041 (47.6)	3714 (43.7)	742 (8.7)
Unknown	72 679	39 268 (54.0)	26 753 (36.8)	6658 (9.2)
Tumor size, cm				
<2	706 379	494 438 (70.0)	161 077 (22.8)	50 864 (7.2)
2-4.9	407 099	194 294 (47.7)	171 985 (42.2)	40 820 (10.0)
≥5-20	82 830	15 351 (18.5)	55 885 (67.5)	11 594 (14.0)
Unknown	28 639	11 831 (41.3)	13 487 (47.1)	3321 (11.6)
Race/ethnicity				
Non-Hispanic white	964 359	573 315 (59.5)	301 041 (31.2)	90 003 (9.3)
Non-Hispanic black	124 091	70 265 (56.6)	46 786 (37.7)	7040 (5.7)
Non-Hispanic other	51 508	26 497 (51.4)	21 616 (42.0)	3395 (6.6)
Hispanic	80 112	42 749 (53.4)	31 577 (39.4)	5786 (7.2)
Unknown	4877	3088 (63.3)	1414 (29.0)	375 (7.7)
Insurance status				
Private	392 391	228 746 (58.3)	111 947 (28.5)	51 698 (13.2)
Medicaid	55 477	27 525 (49.6)	23 228 (41.9)	4724 (8.5)
Medicare	329 512	198 032 (60.1)	118 112 (35.8)	13 368 (4.1)
Other	111 644	64 244 (57.5)	35 384 (31.7)	12 016 (10.8)
Uninsured	21 545	10 602 (49.2)	9374 (43.5)	1569 (7.3)
Unknown	314 378	186 765 (59.4)	104 389 (33.2)	23 224 (7.4)

Abbreviations: L, localized; RE, regional by direct extension only; RE+RN, regional by both direct extension and lymph node involvement; RN, regional by lymph node involvement.

Virginia, and Utah (eTable 3 in the Supplement). Likewise, the proportion of CPMs among women 45 years or older with early-stage unilateral breast cancer treated with surgery substantially varied across states in each time period. For example, during the period from 2010 to 2012, the proportions of patients who underwent a CPM ranged from less than 5% in Massachusetts, Hawaii, and Rhode Island to more than 16% in Colorado (eTable 3 in the Supplement). In general, the highest proportions of women 45 years of age or older who underwent a CPM were observed in select Southern and Midwestern states, and the lowest proportions were found in Northeast and Western states (Figure 2).

Figure 1. Annual Nationwide Proportions of Contralateral Prophylactic Mastectomies (CPMs)



Annual nationwide percentages of CPMs among women with invasive unilateral early-stage breast cancer treated with surgery by age category, 2004-2012. The bars represent the percentage of CPMs among women treated with surgery for unilateral early-stage breast cancer. The vertical error bars represent 95% CIs.

Nationally, the proportion of reconstructive surgical procedures among patients 20 years of age or older with early-stage unilateral breast cancer from 2004 to 2012 increased from 11.6% (5618 of 48 289) to 21.5% (8741 of 40 595) among patients with a UM and from 39.5% (2328 of 5892) to 54.8% (9930 of 18 127) among patients with a CPM (eTable 4 in the Supplement). Reconstructive surgery during this period was more common among younger than older patients for both CPM and UM. In 2012, 37.4% of patients 20 to 44 years of age with a UM (1776 of 4748) and 66.8% with a CPM (3499 of 5237) had reconstructive surgery. The corresponding proportions of patients 45 years of age or older were 19.4% (6965 of 35 847) and 49.9% (6431 of 12 890), respectively.

The proportion of reconstructive surgical procedures among those 20 to 44 years of age who received a CPM from 2004-2006 to 2010-2012 significantly increased in more than half of the states (26 of 45), with the magnitude of the relative increase ranging from 18% in Florida (PR, 1.18; 95% CI, 1.07-1.30) to a 2-fold increase in Virginia (PR, 2.01; 95% CI, 1.63-2.47) (eTable 5 in the Supplement). During the most recent time period (2010-2012), the proportion of reconstructive surgical procedures among patients 20 to 44 years of age who received a CPM ranged from 30.0% (54 of 180) in Oklahoma to 82.1% (252 of 307) in Massachusetts (**Figure 3** and eTable 5 in the Supplement). Similarly, among patients 45 years of age or older who received a CPM, the proportion of reconstructive surgical procedures significantly increased in two-thirds of the states, and during the most recent time period, the proportion varied from 20.4% (109 of 534) in Oklahoma to 66.9% (599 of 895) in New Jersey (eTable 6 in the Supplement). Receipt of reconstructive surgery among patients who received a CPM and use of CPMs by state were not correlated cross-sectionally (r = 0.19; P = .21) or temporally (r = -0.09; P = .57).

The proportion of reconstructive surgical procedures also increased among patients who received a UM during the study period in most states. During the most recent time period (2010-2012), the proportion of reconstructive surgical procedures among women 20 to 44 years of age receiving a UM ranged from less than 20% in Washington, Oklahoma, New Mexico, and Hawaii to 66% in Massachusetts (eTable 7 in the Supplement). Among women 45 years of age or older receiving a UM, the proportion of reconstructive surgical procedrues ranged from about 7% in Alaska (7.2% [19 of 265]), Idaho (6.4% [35 of 548]), and Oklahoma (6.8% [108 of 1592]) to 35.9% (806 of 2243) in Massachusetts. The proportion of reconstructive surgical procedures among patients 20 to 44 years of age who underwent either a UM or a CPM during the period from 2010 to 2012 was correlated with CPM proportions (r = 0.42; P = .005), but the changes in CPM proportions from 2004-2006 to 2010-2012 were not correlated with the corresponding changes in reconstruction proportions among patients who underwent a mastectomy (r = 0.06; P = .68).

Discussion

Using a nationwide population-based cancer database, we found that the proportion of CPMs among patients 20 years or older with early-stage unilateral breast cancer treated with surgery significantly increased from 2004 to 2012 in almost all states, with the absolute proportions substantially higher among patients 20 to 44 years of age than among those 45 years of age or older and in some Midwestern and Southern states than in Western and Northeastern states. In 5 contiguous Midwestern states (South Dakota, Colorado, Nebraska, Iowa, and Missouri), nearly half of the young women who underwent surgery for early-stage unilateral breast cancer during the period from 2010 to 2012 underwent a CPM.

Factors associated with receipt of a CPM that may contribute to variations by state in the proportion of women who underwent a CPM include regional differences in distribution of white race, high socioeconomic status, testing for high-risk genetic mutations, reconstructive surgery for breast symmetry, use of magnetic resonance imaging (MRI), and fear and anxiety surrounding a diagnosis of breast cancer.[12,22-27] However, we found no association between the temporal increases in

Table 2. Proportion of Patients Receiving a Contralateral Prophylactic Mastectomy (CPM) by State and Year Among Women 20 to 44 Years of Age

State	Overall (2004-2012), Patients, No. (%)		Year of Diagnosis, Patients, No. (%)				Change Between Time Periods, PR (95% CI)
			2004-2006		2010-2012		
	Total Cases	CPM	Total Cases	CPM	Total Cases	CPM	
South Dakota	417	165 (39.6)	137	41 (29.9)	136	66 (48.5)	1.62 (1.19-2.21)
Iowa	1644	532 (32.4)	614	132 (21.5)	474	213 (44.9)	2.09 (1.74-2.51)
Colorado	2737	923 (33.7)	888	190 (21.4)	913	407 (44.6)	2.08 (1.80-2.41)
Missouri	3341	868 (26.0)	1216	150 (12.3)	1028	443 (43.1)	3.49 (2.96-4.12)
Nebraska	943	328 (34.8)	342	77 (22.5)	269	115 (42.8)	1.90 (1.49-2.41)
Tennessee	3492	964 (27.6)	1189	176 (14.8)	1116	466 (41.8)	2.82 (2.42-3.29)
Maine	787	225 (28.6)	271	53 (19.6)	250	103 (41.2)	2.11 (1.59-2.80)
Montana	425	111 (26.1)	148	16 (10.8)	138	56 (40.6)	3.75 (2.27-6.22)
Kentucky	2479	656 (26.5)	915	120 (13.1)	762	303 (39.8)	3.03 (2.51-3.66)
Arizona	2677	745 (27.8)	851	148 (17.4)	865	341 (39.4)	2.27 (1.92-2.68)
Connecticut	2441	585 (24.0)	830	104 (12.5)	796	286 (35.9)	2.87 (2.34-3.51)
Florida	9435	2331 (24.7)	3390	515 (15.2)	2935	1041 (35.5)	2.33 (2.13-2.56)
Oregon	1921	539 (28.1)	658	105 (16.0)	650	229 (35.2)	2.21 (1.80-2.71)
Oklahoma	1705	399 (23.4)	634	84 (13.2)	520	180 (34.6)	2.61 (2.07-3.29)
Wisconsin	3129	700 (22.4)	1027	142 (13.8)	1040	340 (32.7)	2.36 (1.98-2.82)
Virginia	4817	993 (20.6)	1657	162 (9.8)	1538	495 (32.2)	3.29 (2.80-3.88)
Mississippi	1525	349 (22.9)	466	52 (11.2)	533	169 (31.7)	2.84 (2.14-3.78)
Georgia	5827	1336 (22.9)	2006	281 (14.0)	1878	594 (31.6)	2.26 (1.99-2.56)
Alabama	2407	514 (21.4)	788	106 (13.5)	743	234 (31.5)	2.34 (1.90-2.88)
Michigan	5163	1106 (21.4)	1836	235 (12.8)	1593	489 (30.7)	2.40 (2.08-2.76)
Pennsylvania	7195	1552 (21.6)	2614	351 (13.4)	2174	658 (30.3)	2.25 (2.01-2.53)
Utah	1154	223 (19.3)	364	21 (5.8)	417	126 (30.2)	5.24 (3.37-8.13)
Texas	9386	1932 (20.6)	2939	310 (10.5)	3172	938 (29.6)	2.80 (2.49-3.16)
New Mexico	888	196 (22.1)	314	47 (15.0)	255	73 (28.6)	1.91 (1.38-2.65)
Ohio	6179	1259 (20.4)	2241	271 (12.1)	1888	539 (28.5)	2.36 (2.07-2.70)
New York	12 668	2509 (19.8)	4456	491 (11.0)	4038	1147 (28.4)	2.58 (2.34-2.84)
Washington	3598	691 (19.2)	1210	124 (10.2)	1231	345 (28.0)	2.73 (2.26-3.30)
Indiana	3203	611 (19.1)	1114	123 (11.0)	970	264 (27.2)	2.47 (2.03-3.00)
North Dakota	323	74 (22.9)	96	13 (13.5)	117	31 (26.5)	1.96 (1.09-3.53)
West Virginia	910	137 (15.1)	319	19 (6.0)	284	75 (26.4)	4.43 (2.75-7.15)
Rhode Island	627	97 (15.5)	238	18 (7.6)	178	46 (25.8)	3.42 (2.05-5.69)
North Carolina	5775	1078 (18.7)	1938	204 (10.5)	1910	490 (25.7)	2.44 (2.10-2.83)
California	20 190	3459 (17.1)	7027	710 (10.1)	6424	1629 (25.4)	2.51 (2.31-2.72)
New Hampshire	864	154 (17.8)	326	29 (8.9)	273	68 (24.9)	2.80 (1.87-4.19)
Delaware	553	74 (13.4)	192	12 (6.3)	165	41 (24.8)	3.98 (2.16-7.31)
New Jersey	5884	1205 (20.5)	2121	317 (14.9)	1755	436 (24.8)	1.66 (1.46-1.89)
Louisiana	2315	394 (17.0)	748	77 (10.3)	774	192 (24.8)	2.41 (1.89-3.08)
Idaho	635	104 (16.4)	186	16 (8.6)	220	54 (24.5)	2.85 (1.69-4.81)
Alaska	330	59 (17.9)	107	11 (10.3)	112	26 (23.2)	2.26 (1.18-4.34)
South Carolina	2564	424 (16.5)	855	81 (9.5)	830	192 (23.1)	2.44 (1.92-3.11)
Nevada[a]	934	129 (13.8)	345	26 (7.5)	139	32 (23.0)	3.05 (1.89-4.93)
Massachusetts	4490	702 (15.6)	1532	139 (9.1)	1404	307 (21.9)	2.41 (2.00-2.91)
Wyoming	202	37 (18.3)	67	<10	78	17 (21.8)	NA
Hawaii	864	106 (12.3)	275	22 (8.0)	286	45 (15.7)	1.97 (1.21-3.19)
District of Columbia	348	32 (9.2)	96	<10	123	18 (14.6)	NA
Arkansas[b]	973	222 (22.8)	504	84 (16.7)	NA	NA	NA

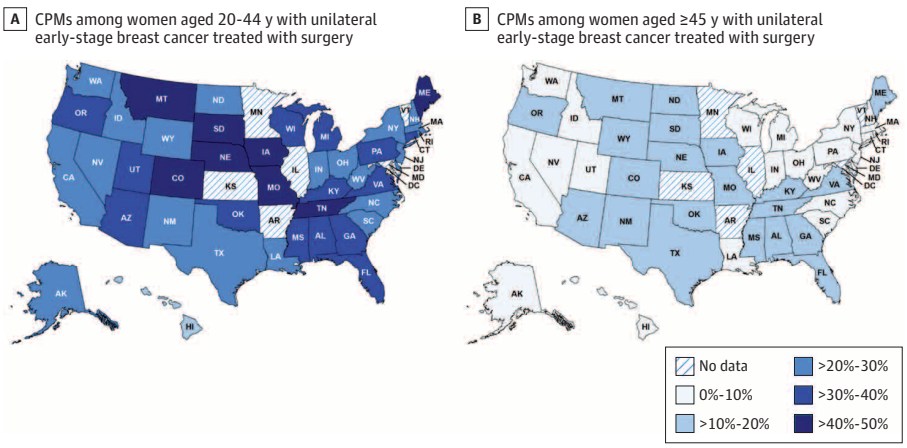
Abbreviations: NA, not applicable; PR, prevalence ratio.

[a] Missing data for years of diagnosis (2011-2012).

[b] Missing data for years of diagnosis (2010-2012).

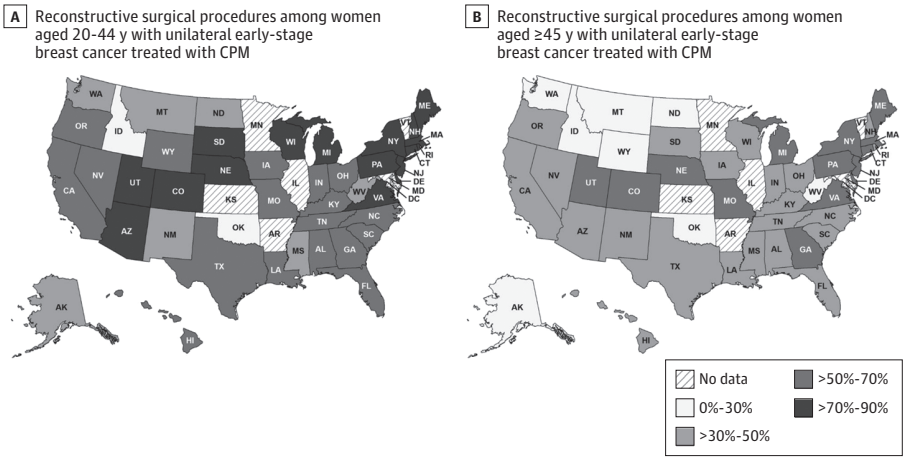
the proportions of reconstructive surgical procedures among patients receiving a CPM by state, nor did we find an association between the 2 proportions by state for the most recent time period. We did find an association among women aged 20 to 44 years between the most recent proportions of CPMs and the proportions of all patients with a mastectomy who underwent

Figure 2. State Variation in Proportions of Contralateral Prophylactic Mastectomies (CPMs) During the Period From 2010 to 2012



A, Percentage of women 20 to 44 years of age with invasive unilateral early-stage breast cancer treated with surgery undergoing a CPM during the period from 2010 to 2012. B, Percentage of women 45 years of age or older with invasive unilateral early-stage breast cancer treated with surgery undergoing a CPM during the period from 2010 to 2012.

Figure 3. State Variation in Proportions of Reconstructive Surgical Procedures Among Women Undergoing a Contralateral Prophylactic Mastectomy (CPM) During the Period From 2010 to 2012



A, Percentage of women 20 to 44 years of age who underwent a CPM for invasive unilateral early-stage breast cancer during the period from 2010 to 2012 who also underwent reconstructive surgery. B, Percentage of women 45 years of age or older who underwent a CPM for invasive unilateral early-stage breast cancer during the period from 2010 to 2012 who also underwent reconstructive surgery.

reconstruction. Interestingly, the highest proportions of young women undergoing reconstructive surgery among young women who had a CPM were geographically clustered in several Northeastern states (Massachusetts, Maine, New Jersey, Connecticut, New York, and Delaware) rather than in the Midwestern region where we observed the highest proportions of women who underwent a CPM, although high proportions of reconstructive surgical procedures among those who had a CPM were observed in South Dakota and Colorado. The aforementioned Northeastern states also showed the highest proportions of reconstructive surgical procedures among those who had a UM.

Several previous studies in the United States have reported an increase in the use of MRI and high-risk genetic testing among patients with breast cancer, coinciding with the increase in the proportion of patients undergoing a CPM nationally.[28-33] However, the use of MRI and high-risk genetic testing among women is unknown by state, and we were unable to assess their contributions to the state variation in the proportions of CPMs among women with breast cancer treated with surgery. One study limited to women 65 years of age or older in the SEER area showed geographic variation in MRI use among SEER registries but without significant difference in mastectomy use between those who underwent MRI and those who did not.[29]

It has been suggested that regional differences in the use of elective surgical procedures largely reflect geographical differences in physician practice, beliefs, and financial incentives rather than differences in patient factors.[34-37] Although BCS has been shown to be an effective and less invasive alternative to mastectomy in the treatment of early-stage breast cancer,[38-41] the use of this procedure varies geographically both within and outside of the United States.[2,13,42-46] One study[47] based on the NCDB found that, in both 1988 and 1994, the proportions of BCS were highest in teaching hospitals and lowest in community hospitals, while 2 later studies[2,4] conducted between 1998 and 2010 showed that proportions of CPMs were highest in teaching

hospitals and lowest in community hospitals, suggesting that there was a transition in surgical treatment by facility type. However, teaching hospitals comprise only about 20% of the hospitals reporting to the NCDB and contribute only about 35% of the cases.[15] Furthermore, our findings do not suggest that state variation in the proportion of women who underwent a CPM reflects geographical differences in the distribution of health care facilities. We found high proportions of CPMs among women with early-stage unilateral breast cancer treated with surgery in both states with mostly community hospitals (eg, South Dakota) and states with many teaching hospitals (eg, Connecticut). We also found lower-than-average proportions of CPMs among women with early-stage unilateral breast cancer treated with surgery in both states with many teaching hospitals (eg, Massachusetts and New York) and in states with very few (eg, Hawaii, Idaho, and Wyoming).

Limitations

To our knowledge, our study is the first to show state-level variation based on population-based data and highlights a contiguous region of states that have substantially higher-than-average proportions of CPMs among women with early-stage unilateral breast cancer treated with surgery. However, a notable limitation of our study is its ecological nature and the lack of individual patient-level or clinician-level data, as well as the lack of health system data to examine reasons for the large state variations in the use of a CPM. Studies have shown that family history, high-risk genetic testing regardless of result, and socioeconomic status are individually associated with receiving a CPM[10,22,48,49]; however, our study lacked data on these variables. Also lacking in our analytical database were important clinical indicators affecting surgical decisions, such as mammographic patterns of diffuse microcalcifications, presence of multiple tumors, and failed lumpectomy attempts.

Studies examining decision aids have suggested that a mastectomy is less likely for early-stage breast cancer among women who are fully informed about surgical options.[50-52] As such, the communication between physicians and patients is a crucial factor affecting decisions about breast cancer surgery, and there is increasing emphasis on shared decision making.[53] In circumstances in which there is greater patient involvement in the decision-making process, there is a higher likelihood of patients having a mastectomy or a CPM.[54,55] In contrast, patients reporting physician-led decisions were more likely to undergo BCS.[50,56] However, variability in physician practices and approaches to decision making with their patients cannot be captured in a study of this nature. Recently, the American Society of Breast Surgeons issued a consensus statement that women with unilateral disease at average risk should be discouraged from undergoing a CPM.[57,58] Future studies could examine the effect of this consensus on halting or reversing the rising proportions of CPMs in the United States, especially in some Midwestern states with the highest proportions.

Conclusions

Using a nationwide population-based database, we found substantial geographical variation in the receipt of a CPM among US women with unilateral breast cancer treated with surgery, with nearly 1 in 2 patients 20 to 44 years of age during the period from 2010 to 2012 receiving a CPM in 5 contiguous Midwestern states. This regional variation was partly explained by state variations in reconstructive surgical procedures among all women with a mastectomy but not among women who underwent a CPM. Future studies should examine patient-level, clinician-level, and health system–level factors to provide additional insight into the reasons for temporal changes and regional variation in the receipt of a CPM. In the meantime, however, surgeons and other health care professionals should educate their patients about the benefit, harm, and cost of a CPM to help patients make informed decisions about their treatments.

ARTICLE INFORMATION

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Study concept and design: Lin, Jemal.
Acquisition, analysis, or interpretation of data: Nash, Goodman, Lin, Freedman, Dominici, Ward.
Drafting of the manuscript: Nash, Lin, Dominici, Jemal.
Critical revision of the manuscript for important intellectual content: Goodman, Lin, Freedman, Ward, Jemal.
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Invited Commentary

Do Patterns of Breast Cancer Surgical Care Reflect National Voting Records?

Lisa A. Newman, MD, MPH

The Midwest is oftenreferred to as *America's heartland*, and is home of the so-called bellwether states whose voting patterns have consistently predicted the outcome for national elections. Patients with breast cancer and breast cancer surgeons are also voters, and it is therefore reasonable to question whether these political patterns can be generalized to oncology practice patterns. If so, then the study by Nash et al[1] in this issue of *JAMA Surgery* indicates that we have not yet seen a peak in the rising rates of contralateral prophylactic mastectomy (CPM) that have been observed among patients in the United States with unilateral breast cancer.

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Similar to reports from a variety of data sets,[2-4] Nash et al[1] demonstrated that rates of CPM have risen substantially during the past 20 years, despite statistics revealing that the more extensive surgery is associated with higher rates of complications; it does not generate a survival advantage, and, with regard to preventing new metachronous primary breast cancers, the procedure reduces but does not eliminate risk.[5] A distinctive feature of the Nash et al[1] North American Association of Central Cancer Registries data set, however, is the broadly representative reporting for 45 states and the District of Columbia. Five geographically contiguous Midwest states were found to have the highest rates of CPM among patients aged 20 to 44 years with breast cancer, resulting in nearly half of this subset choosing CPM during the latter part of the study timeframe (2010-2012).

Contralateral prophylactic mastectomy should be a consideration only among patients who are ineligible for, or unwilling to accept, breast-conserving surgery for the biopsy-proven unilateral cancer. Nash et al[1] cannot account for medical contraindications to breast-conserving surgery such as failed prior lumpectomies or diffuse microcalcifications, but there is no reason to expect either overall increases or geographical variation in the prevalence of these contraindications. Several studies have shown that white American identity and affluence are associated with decisions to undergo CPM. Interestingly, 4 of the 5 Midwestern states with the highest rates of CPM have African American populations no larger than 5% and poverty rates below the 14% national rate.[6,7]

Choices regarding breast cancer surgery—much like casting a ballot—can be intensely personal decisions, based on one's lifetime experiences and exposures, as well as values and resources. Patients and voters alike deserve accurate information regarding realistic expectations from their options. The responsible journalist strives to protect the public from hollow promises by politicians that are all too easily made in the heat of election campaigns. It is an ethical and moral imperative for the responsible surgeon to insure that patients with breast cancer are well informed regarding treatment choices that are medically safe and that prioritize optimal oncologic outcomes. We must respect patient choice and avoid being paternalistic, but we must also protect our patients from making impulsive surgical decisions when they are freshly encumbered by the panic accompanying a new diagnosis of breast cancer.

ARTICLE INFORMATION

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