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# The Impact of Surgeons on the Likelihood of Mastectomy in Breast Cancer

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**Objective:** This study evaluates the impact of individual surgeons and institutions on the use of mastectomy or breast conserving surgery (BCS) among elderly women with breast cancer.

**Summary of Background Data:** Current literature characterizes patient clinical and demographic factors that increase likelihood of mastectomy use. However, the impact of the individual provider or institution is not well understood, and could provide key insights to biases in the decision-making process.

**Methods:** A retrospective cohort study of 29,358 women 65 years or older derived from the SEER-Medicare linked database with localized breast cancer diagnosed from 2000 to 2009. Multilevel, multivariable logistic models were employed, with odds ratios (ORs) used to describe the impact of demographic or clinical covariates, and the median OR (MOR) used to describe the relative impact of the surgeon and institution.

**Results:** Six thousand five hundred ninety-four women (22.4%) underwent mastectomy. Unadjusted rates of mastectomy ranged from 0% in the bottom quintile of surgeons to 58.0% in the top quintile. On multivariable analysis, the individual surgeon (MOR 1.97) had a greater impact on mastectomy than did the institution (MOR 1.71) or all other clinical and demographic variables except tumor size (OR 3.06) and nodal status (OR 2.95). Surgeons with more years in practice, or those with a lower case volume were more likely to perform mastectomy ($P < 0.05$).

**Conclusion:** The individual surgeon influences the likelihood of mastectomy for the treatment of localized breast cancer. Further research should focus on physician-related biases that influence this decision to ensure patient autonomy.

**Keywords:** breast cancer, breast conservation, decision-making, mastectomy, patient autonomy, patterns of care, quality of care

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Dr. Isabel Boero had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. These institutions had no role in the creation of this manuscript. This study used the linked SEER-Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors.

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This is a population-based study using SEER-Medicare merged with AMA Physician Masterfile data to determine role of the individual surgeon in receipt of mastectomy among elderly women with breast cancer.

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In 2014, approximately 215,000 women were diagnosed with nonmetastatic invasive breast cancer in the United States; 95% underwent surgery as part of their treatment.[1] Mastectomy and breast-conserving surgery (BCS or lumpectomy) represent the 2 primary surgical options used to treat invasive cancer. Numerous randomized trials from the United States and Europe conducted in the 1980s have consistently shown that BCS followed by radiation provides equivalent long-term disease control and survival compared with mastectomy.[2–5] This decision of whether to pursue mastectomy or BCS represents one of the most difficult decisions patients with breast cancer will make, and therefore, understanding the factors that influence this decision are a subject of critical importance.

Existing research to understand what drives women toward BCS or mastectomy appropriately focuses on the influence of patient demographics such as race, socioeconomic status, age, and geography, as well as clinical factors such as tumor stage or size, breast anatomy, and comorbidity. However, as the surgeon and treating institution are central components in breast cancer management, the impact of these players on the use of mastectomy versus BCS also deserves attention. Ideally, women with breast cancer should receive an unbiased presentation of all treatment options, including mastectomy and BCS, with the ultimate decision coming directly from patient preference in the context of an evidence-based discussion of risks and benefits. However, physician or institutional biases have the capacity to sway patient decision-making resulting in greater than expected variability in patterns of care.

Some variation in health care delivery is expected. For example, certain patients have tumors or anatomy that make them ineligible for BCS or underlying conditions that make them poor candidates for mastectomy. In addition, individual patient preference should vary. Quantifying this variability, and understanding component factors—namely physicians and institutions—is key to understanding structural biases in the current decision-making process.

Earlier studies show moderate influence of surgeons on the management of their breast cancer.[6,7] However, no recent analysis has fully characterized the impact of the individual breast surgeon and institution on the likelihood of a specific treatment. The goal of this study was to evaluate the impact of individual surgeons on the likelihood of mastectomy in a large cohort of Medicare beneficiaries with breast cancer.

## METHODS

### Data Source

We identified female breast cancer patients from the Surveillance, Epidemiology, and End Results (SEER)-Medicare linked database. The National Cancer Institute manages the SEER program, which pools data from individual cancer registries from across the United States and covers 28% of the population. Medicare provides federally funded health insurance for individuals in the US over the age of 65. The SEER-Medicare linkage provides Medicare claims for all Medicare beneficiaries within SEER. Medicare claims data capture information about a patient's cancer treatment including the treating provider, which enables us to study the influence of the provider on patterns of care in breast cancer. The Institutional Review Board of the University of California San Diego deemed this study exempt from review.

### Study Population

An initial query of the SEER-Medicare database identified 135,162 patients at least 66 years old who were diagnosed between 2000 and 2009 with histologically confirmed, nonmetastatic breast cancer. Patients were required to have continuous Part A and B coverage from 1 year before diagnosis until death or the end of the study period (December 2010) to allow for the ascertainment of comorbidities before diagnosis and the identification of the surgeon responsible for operative treatment. Patients with Part C coverage were excluded from the study because managed care organizations do not routinely submit detailed claims information resulting in incomplete claims data. Additional patient selection criteria are described below, and the final study cohort included 29,358 patients. The complete patient selection schema is shown in Supplemental Figure 1, http://links.lww.com/SLA/B378.

### Study Covariates

SEER was used to identify patient characteristics such as age at diagnosis, race, marital status, year of diagnosis, primary tumor size and grade, laterality, number of positive nodes, and median household income by census track. Patients with a primary tumor greater than 5 cm were excluded from further analysis, as tumors of this size are a relative contraindication to BCS.[8] Inpatient and outpatient Medicare claims from the year before diagnosis were used to assess pre-existing comorbidity using the Deyo adaptation of the Charlson comorbidity index.[9] The administration of chemotherapy was ascertained using previously described methods, namely by identifying chemotherapy administration codes within a patient's Medicare files.[10] Care at a teaching hospital was defined as any indirect medical education payment noted during a hospitalization after the patient's diagnosis of cancer. The use of breast MRI after diagnosis to account for possible stage migration was identified using Healthcare Common Procedure Coding System (HCPCS) codes (Supplemental Table 1, http://links.lww.com/SLA/B378). Patient characteristics are presented in Table 1.

### Surgery and Surgeon Identification

Breast conserving surgery or mastectomy was identified with Medicare claims data using relevant International Classification of Diseases 9th Revision (ICD-9) and HCPCS codes (Supplemental Table 1, http://links.lww.com/SLA/B378). Among patients who had multiple breast surgeries, only the first surgery was considered. The specific surgeon was identified from the Unique Physician Identification Number (UPIN) or National Provider Identifier (NPI) associated with the Medicare claim. Patients without an identifiable provider were excluded from further evaluation.

We identified physician characteristics from a tertiary linkage with the American Medical Association Masterfile based on UPIN and NPI numbers. Physician characteristics evaluated included sex, medical school year of graduation, primary employment arrangement, training outside the US, and the annual completion of 50 hours of continuing medical education (CME). The American Medical Association data contain physician self-designated specialty information. We defined provider specialty as those who self-identified as "general surgeons" or "surgical oncologists," with all other designations included in a category termed "other." To assess the impact of the volume of breast cancer patients treated, providers were ranked in quartiles according to number of breast cancer patients managed within the study cohort. We identified the physician's practicing hospital that was used to control for institutional effects. We excluded patients treated by providers without a known institution.

### Statistical Analysis

This study sought to understand the impact of individual provider and treating institution on the likelihood of mastectomy. We used Chi-squared tests to evaluate the unadjusted differences between patients receiving mastectomy and those treated with BCS. We then used hierarchical multivariable logistic regression models with patients (Level 1) nested within providers (Level 2) and then clustered by hospital (Level 3) to understand the role of physicians and their institution.[11,12] All patient- and physician-level covariates were defined a priori based on clinical and demographic factors that could influence the likelihood of mastectomy and were categorical with subgroups presented in Table 1. To graphically display the variability in mastectomy use, we plotted the observed and adjusted rates of mastectomy while grouping providers into quintile based on observed mastectomy usage (Fig. 1). With the adjusted rates, we calculated the predicted likelihood of mastectomy for each patient and then determined the adjusted rate of mastectomy per provider[13,14] using the multilevel model described below. We presented the observed and adjusted median rates of mastectomy per provider quintile.

We calculated median odds ratio (MOR) for the provider and hospital separately to determine their association with mastectomy use.[15] The MOR translates both the provider and institutional level variation to the scale of odds ratios facilitating a comparison to the model's fixed effects.[16,17] The MOR also expresses the likelihood of a patient receiving a different outcome if the patient were to change providers or hospital. For example, if the MOR for providers was to equal 1, then there would be no difference in the likelihood of mastectomy between providers; however, if this MOR were equal to 1.5, then a patient would have 50% greater odds of mastectomy if treated by 1 randomly selected provider as opposed to another. We calculated the confidence interval (CI) for MOR using bootstrapping and Delta method with a total of 1000 resampling datasets generated.[18] We also partitioned the explained variance in the use of mastectomy using a conditional $R^2$ for generalized linear mixed models.[19] We utilized PROC GLIMMIX in SAS version 9.4 (SAS Institute Inc, Cary, NC) to perform our multilevel analyses with the residual pseudo-likelihood estimation technique.[20] All statistical tests performed were 2-sided with a $P$ value $< 0.05$ considered statistically significant.

## RESULTS

Our final cohort included 29,358 women treated by 1752 providers of whom 6594 underwent mastectomy as their primary surgery. The majority of patients were between 66 and 74 years old with tumors less than 2 cm and negative lymph nodes. Most were

**TABLE 1.** Patient Characteristics for the Entire Cohort and for Those who Underwent Mastectomy

| | Entire Cohort (%) | Mastectomy Cohort (%) | *P** |
|---|---|---|---|
| Total | 29,358 | 6594 | |
| Patient characteristics | | | |
| Age at diagnosis | | | |
| 66–74 | 12,252 (41.7) | 2521 (38.2) | <0.001 |
| 75–79 | 7091 (24.2) | 1544 (23.4) | |
| ≥80 | 10,015 (34.1) | 2529 (38.4) | |
| Race/ethnicity | | | |
| White | 26,581 (90.5) | 589 (88.6) | <0.001 |
| Black | 1376 (4.7) | 352 (5.3) | |
| Other | 1401 (4.8) | 403 (6.1) | |
| Marital status | | | |
| Married | 13,220 (45.0) | 2725 (41.3) | <0.001 |
| Divorced | 1941 (6.6) | 460 (7.0) | |
| Single | 1885 (6.4) | 442 (6.7) | |
| Other | 12312 (42.0) | 2967 (45.0) | |
| Charlson Comorbidity Index | | | |
| 0 | 18,879 (64.3) | 4082 (61.9) | <0.001 |
| 1 | 6778 (23.1) | 1568 (23.8) | |
| 2 | 2284 (7.8) | 556 (8.4) | |
| ≥3 | 1417 (4.8) | 388 (5.9) | |
| Primary tumor size, cm | | | |
| 0–2 | 20,816 (70.9) | 3111 (47.2) | <0.001 |
| >2–5 | 8542 (29.1) | 3482 (52.8) | |
| Nodes positive | | | |
| None | 18,782 (64.0) | 3654 (55.4) | <0.001 |
| 1–3 | 4515 (15.4) | 1656 (25.1) | |
| ≥4 | 1831 (6.2) | 1015 (15.4) | |
| Unknown | 4230 (14.4) | 269 (4.1) | |
| Grade | | | |
| Well or moderately differentiated | 19,945 (67.9) | 3967 (60.1) | <0.001 |
| Poor or undifferentiated | 7456 (25.4) | 2252 (34.2) | |
| Unknown | 1957 (6.7) | 375 (5.7) | |
| Laterality | | | |
| Left | 14,903 (50.8) | 3379 (51.2) | 0.38 |
| Right | 14,455 (49.2) | 3215 (48.8) | |
| Year of diagnosis | | | |
| 2000–2003 | 9745 (33.2) | 2265 (34.3) | <0.001 |
| 2004–2006 | 8246 (28.1) | 1587 (24.1) | |
| 2007–2009 | 11,367 (38.7) | 2742 (41.6) | |
| Teaching Hospital | 11,195 (38.1) | 3004 (45.6) | <0.001 |
| Breast MRI | 3011 (10.3) | 790 (12.0) | <0.001 |
| Chemotherapy | 5632 (19.2) | 1921 (29.1) | <0.001 |
| Provider characteristics† | | | |
| Sex | | | |
| Male | 21,999 (74.9) | 5225 (79.2) | <0.001 |
| Female | 7359 (25.1) | 1369 (20.8) | |
| Primary specialty | | | |
| General Surgery | 25,697 (87.5) | 5830 (88.4) | 0.01 |
| Surgical Oncology | 1810 (6.2) | 354 (5.4) | |
| Other | 1851 (6.3) | 410 (6.2) | |
| Medical school year of graduation | | | |
| <1970 | 4932 (16.8) | 1256 (19.0) | <0.001 |
| 1970–1980 | 10,853 (36.9) | 2428 (36.8) | |
| 1981–1990 | 10,970 (37.4) | 2318 (35.2) | |
| >1991 | 2603 (8.9) | 592 (9.0) | |
| Present employment | | | |
| Self-employed | 11,189 (38.1) | 2527 (38.3) | 0.02 |
| Group practice | 13,356 (45.5) | 3045 (46.2) | |
| Government | 2762 (9.4) | 551 (8.4) | |
| Other | 2051 (7.0) | 471 (7.1) | |
| US Trained | 25,146 (85.7) | 5718 (86.7) | 0.01 |
| Completed at least 50 h of continuing medical education annually | 2169 (7.4) | 378 (5.7) | <0.001 |

Chi-squared tests were used to evaluate significant differences in clinical and hospital characteristics for patients who underwent a mastectomy and those who underwent breast-conserving surgery (BCS).

*Chi-squared test comparing patients receiving mastectomy to those that BCS.

†Expressed in terms of number of patients treated by a specific type of provider.

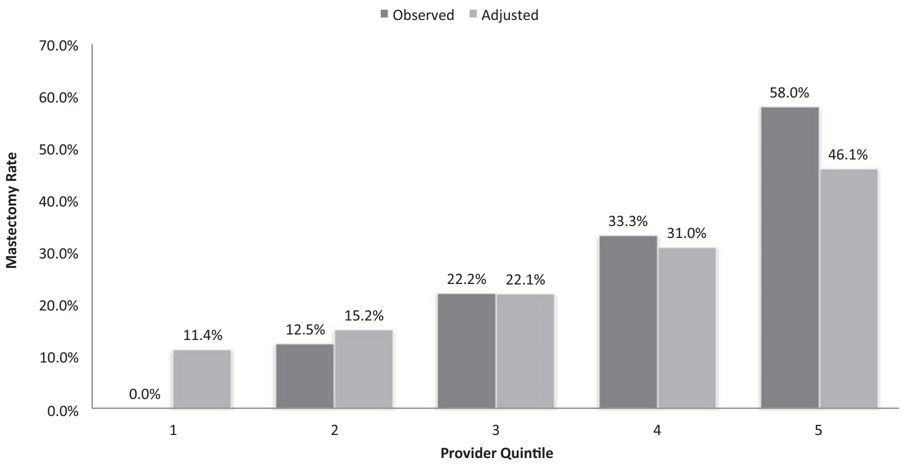


**FIGURE 1.** Observed (dark blue) and adjusted (light blue) median rates of mastectomy stratified by provider quintile of mastectomy usage (1= providers with the lowest rate of mastectomy; 5 = providers with the highest rate of mastectomy). Adjusted rates of mastectomy were determined using a hierarchical logistic model controlling for patient, tumor, and provider characteristics. Rates of mastectomy are presented above each column.

treated by US-trained, male general surgeons who graduated from medical school after 1970 and were members of a group practice. Overall mastectomy rates increased throughout the study period, although contraction occurred in 2004 to 2006. Women who underwent mastectomy were more likely to be older ($\geq$80 years of age) with large tumors that were high grade or involved lymph nodes (Table 1).

Observed median rates of mastectomy use by surgeon demonstrated marked variation ranging from 0% in the bottom quintile of surgeons to 58.0% in the top quintile. After multivariable adjustment, the expected median rates of mastectomy were estimated at 11.4% in the lowest quintile and 46.1% for the highest quintile (Fig. 1).

Significant predictors of mastectomy identified through multivariable analysis controlling for patient- and provider-related factors included older age, a primary tumor larger than 2 cm, having positive lymph nodes, a high tumor grade, receiving chemotherapy or a breast magnetic resonance imaging (MRI), being treated at teaching hospital, or by a surgeon who specialized in surgical oncology. Conversely, having higher income, no nodal exploration, being treated by a surgeon in practice for fewer years (based on medical school graduation year), being treated by a surgeon who trained internationally, or cared for by a physician with a high volume of breast cancer cases significantly reduced the likelihood of undergoing mastectomy.

Using the MOR to understand the relative impact of the provider and hospital on the use of mastectomy, we found that the MOR of the provider was 1.97, 95% CI: 1.71–2.27), while the MOR for the hospital was 1.71 (95% CI: 1.56–1.89). The MOR for the provider was greater than the odds ratios of all patient and clinical covariates except for tumor size and nodal status. The MOR for provider and hospital indicated that a patient would have nearly double the odds of mastectomy if treated by 1 provider as opposed to another. The complete multivariable analysis is presented in Fig. 2. Of variance explained by the multilevel model, 14.9% was attributable to the hospital, 23.7% was attributable to the provider, and 61.4% was due to the fixed effects.

Further analysis evaluating regional differences in states with sufficient patient samples found that the impact of the provider and hospital varied by where patients receive care (Fig. 3). The MOR for provider ranged from 1.29 (Georgia) to 2.67 (Connecticut), whereas the MOR for hospital ranged from 1.14 (Seattle) to 2.63 (New Mexico).

## DISCUSSION

Since the 1930s, epidemiological reports have suggested that a patient's odds of undergoing a particular surgical procedure may depend more on where he or she lives than on the patient's clinical presentation.[21–26] In breast cancer, geography can limit access to a radiation therapy facility, which is required for most patients undergoing BCS, and therefore impacts mastectomy rates.[27] Variation also tends to be greatest for discretionary or patient preference sensitive procedures, of which breast surgery is a prime example.[22]

The goal of this study was to provide insight into elements of the health care system that could influence the rate of mastectomy—namely the provider and the treating institution. Differences in tumor characteristics, illness burden, and patient preferences all appropriately influence treatment decisions. However, this study found that both the individual surgeon and institution play a sizable role in the likelihood of elderly women receiving a mastectomy.

Previous work by Hawley et al[7] surveyed surgeons in the Los Angeles and Detroit areas and found that surgeons explained 9.9% of the variation in mastectomy in the patients in those areas. A later study by Katz et al[6] on patients in Detroit and Los Angeles from 2005 to 2007 noted that surgeons explain only 4% of the variation in mastectomy use. Our result was comparable when considering the percentage of the total variance explained by the provider (9.4%). More recently, Feigelson et al,[28] in a study of patients from 4 institutions, determined that providers had a MOR of 1.75 (95% CI, 1.46–2.87), similar to our results (MOR 1.97). Comparing these values between studies presents challenges due to the wide range of statistical techniques and study populations, but these results illustrate that the provider consistently plays an important role in procedure selection. Our study builds on these prior findings by demonstrating the impact of both the individual surgeon and the treating institution across a national sample of patients, providers, and hospitals, and providing a statistical comparison to relative impact of patient clinical and demographic factors.

Understanding which aspects of the interaction between the patient and the health care system influences patient choice between mastectomy and BCS deserves further discussion. The interplay of information between patient and physician naturally has the capacity to add bias into this process. In breast cancer, some have hypothesized that rates of BCS remained low because eligibility criteria for BCS were unclear and/or not communicated to patients, and therefore, patients may believe that more extensive surgery translates

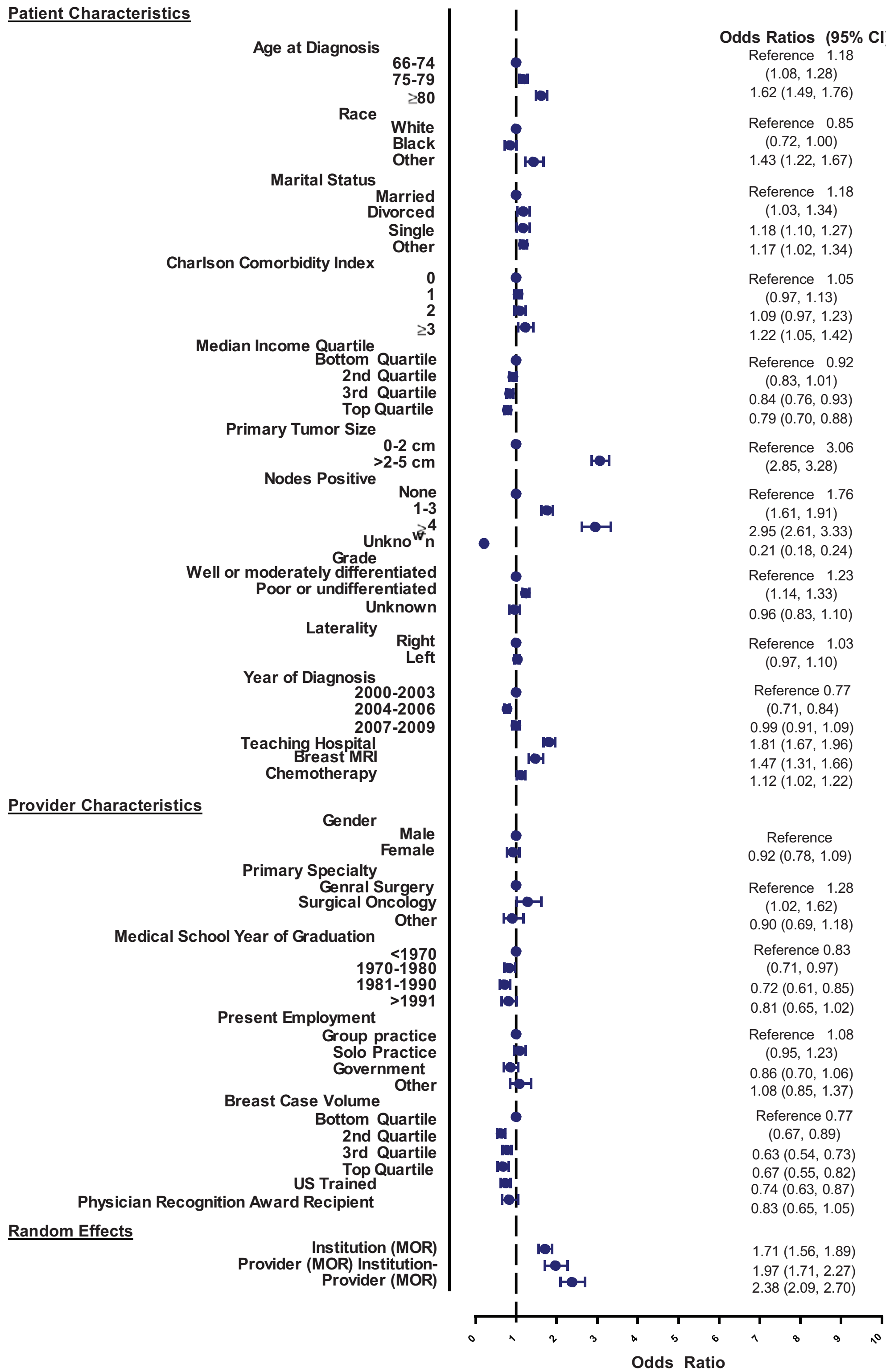


**FIGURE 2.** Forest plot for the adjusted odds ratios for patient and provider characteristics (fixed effects) showing the likelihood of mastectomy. Exact odds ratios and median odds ratios (MORs) with 95% confidence intervals (95% CIs) are also presented. An odds ratio greater than 1 favors mastectomy, while an odds ratio less than 1 favors BCS. The MOR for the model's random effects, the provider and the associated institution, are comparable to the model's fixed effects.

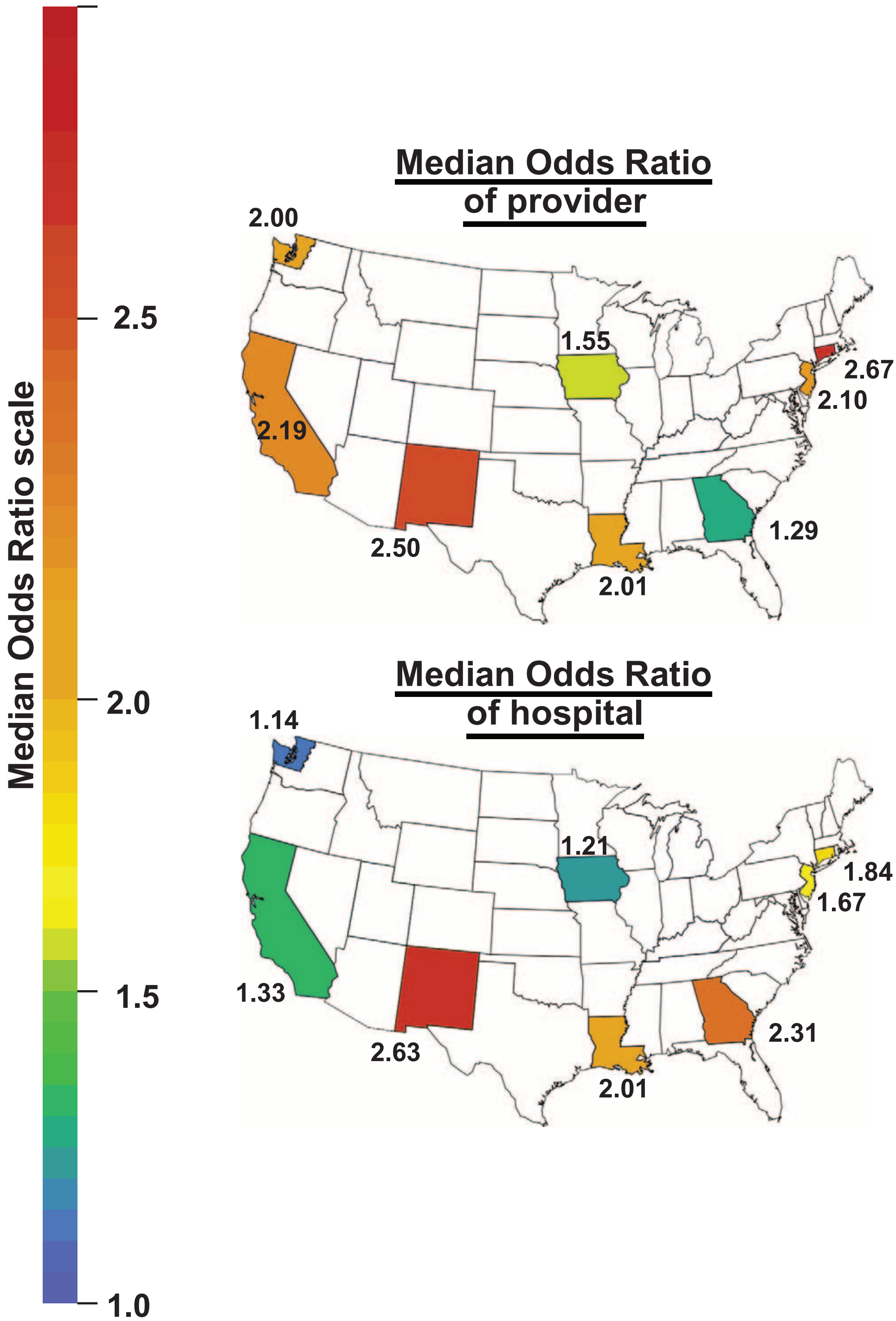


**FIGURE 3.** The median odds ratio (MOR) for hospital and provider stratified by state. The MOR for provider ranged from 1.29 (Georgia) to 2.67 (Connecticut), whereas the MOR for hospital ranged from 1.14 (Seattle) to 2.63 (New Mexico).

to improved survival.[29] Interestingly, previous work has shown that patients report wide variation in their role in the decision-making process[30] with early studies showing that patients who consult a medical oncologist are more likely to undergo mastectomy.[31] Efforts to reduce provider bias could potentially include the increased use of multidisciplinary clinics, improved patient or physician education,[22] or implementation of shared decision making tools.[32] Shared decision aids have been shown to increase patient knowledge about surgical treatment options in early-stage breast cancer[33] and when used in a randomized trial setting, have been shown to increase the rate of breast conservation from 76% to 94%.[34] Multi-disciplinary tumor board conferences have been reported to increase recommendations for breast conservation.[35] Lastly, provider feedback regarding risk-adjusted rates of mastectomy compared with their colleagues may be effective, and could include an initiative within a single institution given the impact of institution was lower in this study than the impact of individual provider. Regardless of the approach, the ultimate goal should be to better respect patient autonomy.[36]

In addition to demonstrating the impact of the surgeon and institution, our study also highlights provider-related characteristics likely to influence the likelihood of mastectomy. Similar to research by Hershman et al,[37] we found that providers who graduated after 1970 were more likely to perform BCS. Patterns of care correlating with time since graduation are thought to reflect persistence of knowledge and skills learned during training, due in part to suboptimal continuing education programs as well as fundamental difficulties with de-intensification of effective therapies.[38] In contrast to the findings by Hershman et al,[37] however, we found that US-trained providers were more likely to perform mastectomy than those trained outside the US.[37] Of note, our study focused on patients treated from 2000 to 2009, while Hershman et al[37] evaluated patients and providers from an earlier time period (1991 to 2002). We also found that surgical oncologists were more likely to perform mastectomy, a previously unreported association; however, this observation might reflect the fact that surgical oncologists may treat more complicated patients. In addition, those with less experience, and a lower volume of breast cancer cases were marginally more likely to perform mastectomy than BCS, similar to findings reported elsewhere.[37,39] Finally, we found that the influence of the individual provider and treating hospital on mastectomy rates varied substantially by geographic region. The source of this geographic variability remains unknown, though potential factors include geography-based differences in physician training,[40] regional differences in patient-physician communication,[41] or other unknown causes of geographic variability in health care delivery.

This study has limitations that must be acknowledged. As our cohort was limited to Medicare beneficiaries over the age of 65, these results may not be generalizable to younger women or those with private insurance. However, we suspect that providers would not substantially change their practice patterns with younger patients or those with private insurance, though research among a non-Medicare population would be required to confirm this assumption. In addition, this dataset does not include data on a number of potentially confounding covariates that may influence mastectomy rates such as positive margins, the presence of multicentric disease or concurrent, extensive ductal carcinoma in situ, BMI, or the ratio of tumor size to breast size. Finally, with the administrative data available in this project, we cannot comment on factors such as patient choice, psychosocial factors, health behaviors, or patient-physician communication, which are all critical in this decision-making process.

Despite these limitations, our study found a substantial and independent association between individual provider, the treatment center, and the type of breast surgery among elderly women with breast cancer. Reduction in this health care system-related variability will require concerted/systemic efforts to ensure that well-informed patients are the principal drivers of treatment decisions.

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