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Author manuscript
J Geriatr Oncol. Author manuscript; available in PMC 2024 July 05.

Published in final edited form as:
J Geriatr Oncol. 2024 June ; 15(5): 101795. doi:10.1016/j.jgo.2024.101795.

Physician-level variation in axillary surgery in older adults with T1N0 hormone receptor-positive breast cancer: A retrospective population-based cohort study☆

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Abstract

Introduction: We sought to determine how considerations specific to older adults impact between- and within-surgeon variation in axillary surgery use in women ≥70 years with T1N0 HR+ breast cancer.

Materials and Methods: Females ≥70 years with T1N0 HR+/HER2-negative breast cancer diagnosed from 2013 to 2015 in SEER-Medicare were identified and linked to the American Medical Association Masterfile. The outcome of interest was axillary surgery. Key patient-level variables included the Charlson Comorbidity Index (CCI) score, frailty (based on a claims-based frailty index score), and age (≥75 vs <75). Multilevel mixed models with surgeon clusters were

☆This study was presented as poster at the American Society of Clinical Oncology (ASCO) Quality Care Symposium in Chicago, Illinois in September 2022.

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Appendix A. Supplementary Data
Supplementary data to this article can be found online at https://doi.org/10.1016/j.jgo.2024.101795.

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used to estimate the intracluster correlation coefficient (ICC) (between-surgeon variance), with 1-ICC representing within-surgeon variance.

Results: Of the 4410 participants included, 6.1% had a CCI score of ≥3, 20.7% were frail, and 58.3% were ≥ 75 years; 86.1% underwent axillary surgery. No surgeon omitted axillary surgery in all patients, but 42.3% of surgeons performed axillary surgery in all patients. In the null model, 10.5% of the variance in the axillary evaluation was attributable to between-surgeon differences. After adjusting for CCI score, frailty, and age in mixed models, between-surgeon variance increased to 13.0%.

Discussion: In this population, axillary surgery varies more within surgeons than between surgeons, suggesting that surgeons are not taking an “all-or-nothing” approach. Comorbidities, frailty, and age accounted for a small proportion of the variation, suggesting nuanced decision-making may include additional, unmeasured factors such as differences in surgeon-patient communication.

Keywords

Breast cancer; Geriatric oncology; Frailty; Life expectancy; Locoregional therapy; Surgery

1. Introduction

As the United States (U.S.) older adult population grows, so does the incidence of breast cancer among older adults. In recent years, women ≥70 years old have comprised approximately 30% of new breast cancer diagnoses [1]. Approximately 80% of these patients develop hormone receptor (HR)-positive disease [2], and of these, over 65% present with stage I disease [3], making questions of locoregional management especially relevant. Axillary management in this group has garnered increasing attention [4–6] as a Choosing Wisely recommendation [7], the National Comprehensive Cancer Network guidelines [8], and a recommendation by the International Society of Geriatric Oncology [9] support omission of sentinel lymph node biopsy (SLNB) [10–12] in appropriately chosen older patients with breast cancer. These guidelines and recommendations are supported by randomized controlled trial data from the International Breast Cancer Study Group (IBCSG) 10–93 [10] trial of axillary lymph node dissection (ALND) vs no-ALND in women ≥60 with clinically node-negative disease published in 2006, and Martelli et al.’s trial of ALND vs no-ALND in women >65 with clinical T1N0 disease undergoing quadrantectomy, whose five-year follow-up was published in 2005, with 15-year follow-up published in 2012 [12,13]. The Cancer and Leukemia Group B (CALGB) 9343 trial, which examined omission of radiation therapy (RT) in women >70 with T1N0 estrogen receptor-positive (ER+) disease, discouraged axillary surgery, and thus over 60% of patients in each trial arm had no axillary surgery [11]. Although these trials tested ALND vs no-ALND, and SLNB, which is a smaller surgery in which only the first lymph nodes are removed rather than all level I-II axillary lymph nodes, the data are applied to modern practice as these trials demonstrated the lack of overall survival decrement and low axillary recurrence rates (3–6%) in patients who had axillary surgery completely omitted. SLNB may have perceived benefits, such as assisting in adjuvant chemotherapy and RT decisions [14], and it carries significantly lower surgical morbidity risks than ALND, but this procedure still requires

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additional time under anesthesia, increased operating cost, a 3–5% risk of lymphedema, risk of seroma, and pain [15,16].

Despite this, axillary surgery rates remain high in this population: over 80% in national cancer databases in the United States. Previous studies have shown that this rate has remained stubbornly high in the year before and following the landmark publication of CALGB 9343 in 2013 [4,5,17]. While facility-level variation has been noted [17], the role of individual surgeons is unclear. We thus sought to quantify the variation attributable to the surgeon's level in the years immediately following the publication of CALGB 9343. Between-surgeon differences may be viewed as consequences of not only individual surgeon preference/knowledge, but also of system-level factors, such as geographical location, financial incentives, or social-network influences. Within-surgeon differences may develop due to treatment differences among older/sicker patients treated by the same physician, or due to unmeasured factors at the level of the patient-provider interaction. Given that our previous work has shown that surgeons, medical oncologists, and radiation oncologists view this question of omission of axillary surgery as a nuanced one [14], with numerous disease and patient factors feeding into the surgical decisions, we hypothesized that we would find higher within-surgeon variation than between-surgeon variation, reflecting a patient-centered approach.

2. Methods

2.1. Data Source

This study used the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset. SEER, which is a program of the National Cancer Institute, reports incident cancer cases in areas representing 28% of the U.S. population [18]. Data including patient demographics, tumor characteristics, staging details, surgical and adjuvant therapy treatments (chemotherapy, targeted therapy, immunotherapy, and radiation therapy [RT]), and outcomes are included using nationally standardized coding guidelines. Since 1991, these data have been linked with administrative Medicare data for individuals enrolled in fee-for-service. The addition of the Medicare data allows examination of Current Procedural Terminology (CPT) codes to verify cancer registry procedure coding, allowing us to discern whether or not the patient had axillary surgery (SLNB or ALND). The Medicare physician claims also contain a unique physician identifier, which was used to link the SEER-Medicare data with data from the American Medical Association (AMA) Masterfile to access surgeon-level data. Linkage of these two datasets has been reported to be over 98% [19,20]. Given that this dataset used previously collected, limited data, it was deemed exempt for review by the Massachusetts General Brigham Institutional Review Board (IRB review date: 10/16/2020; protocol number 2020P003218).

2.2. Sample

Females aged ≥70 years old with T1N0 HR+/human epidermal growth factor receptor 2 (HER2)-negative breast cancer diagnosed from January 2013 through October 2015 in SEER-Medicare were identified. The start date of our analysis was based on the 2013 publication of the long-term follow-up of the CALGB 9343 study [11] which, although

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preceded by other randomized controlled trial data [10,12], is considered a landmark study in omission of axillary surgery in our population of interest. Given that our claims-based frailty measure [21] was originally described using the International Classification of Diseases (ICD)-9 codes, the endpoint of the analysis was chosen to exclude the time after the change to ICD-10 coding. These SEER-Medicare data were linked to the AMA Masterfile to acquire surgeon-level data. All patients were assigned to the surgeon associated with their primary breast surgery claim. Participants who were enrolled in Medicare Parts A/B and not a health maintenance organization (HMO) from one year before diagnosis through to one year after diagnosis were included. Those who were treated by low-volume surgeons (defined as those performing <5 cases in this population during the study period, similar to previous studies [20]), who could not be assigned to a surgeon in the AMA dataset, had an unknown surgery type, unknown receptor status, who were male, who underwent neoadjuvant RT or post-mastectomy RT, had a previous history of breast cancer, or who were diagnosed by autopsy or death certificate were excluded (Supplemental Fig. 1).

2.3. Variables

The outcome of interest was axillary surgery, defined as SLNB and/or ALND. As the extent of lymph node surgery may be under-reported in SEER [22], CPT codes for SLNB and ALND were used to ensure the most accurate coding possible.

Key patient-level variables included chronologic age (≥75 vs <75) and frailty status, based on a claims-based frailty index score (frail vs. non-frail). Frailty was defined using Kim et al.'s validated claims-based frailty indicator [21]. This frailty index incorporates administrative codes for durable medical equipment claims, comorbid conditions, and healthcare facility use in the prior year. A score of ≥0.25 designates a patient as frail, with those with a score of <0.25 designated as not-frail, as has been done in previous studies [23]. Surgeon-level variables from the AMA data included sex, years in practice, self-identified practice type (surgical oncology vs. general surgery), practice region, and practice volume over the study period (by quartile).

Other patient-level covariates included age, race and ethnicity (African American/Black, Hispanic/Latinx, Non-Hispanic/Latinx White, other, and unknown), Charlson Comorbidity Index (CCI) (0,1,2,3,≥4), regional location of the patient's home ZIP code (urban or rural), median income of patient's ZIP code (quartiles), SEER region (West, Northeast, Midwest, or South) and year of diagnosis. Disease characteristics included tumor grade (1,2,3), tumor stage (T1a, T1b, or T1c), and tumor histology (invasive ductal carcinoma, invasive lobular carcinoma, or other).

2.4. Statistical Analysis

Differences in categorical variables were determined using chisquare tests. Multilevel mixed models with surgeon clusters were used to estimate the intracluster correlation coefficient (ICC) (between-surgeon variance), with 1-ICC representing the within-surgeon variance. The ICC was calculated by dividing the between-group variance by the total variance. The first model ("empty model") was run with physician random intercepts without covariates. To determine the extent to which patient-level factors may "adjust away" some

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of the within-surgeon variation in axillary surgery, we sequentially introduced covariates of interest. Models that included frailty, chronological age, and CCI, were each run separately. Then, a model with all three patient-level variables of interest was run, and then finally, a model that included all remaining covariates. Generalized linear models were additionally used to identify patient-level and surgeon-level factors associated with the receipt of axillary surgery. *P*-values were based on two-sided tests, with significance defined as $p < 0.05$. All analyses were performed using SAS software, v.9.4 (SAS Institute, Cary, NC).

3. Results

Of the 4410 participants included, 58.3% were ≥75 years old, 20.7% were frail, and 2.7% had a CCI of ≥4; 13.9% had axillary surgery omitted (Table 1). A greater proportion of participants ≥85 years old had axillary surgery omitted (46%) vs. participants aged 70–74 (3.7%, $p < 0.001$). A greater proportion of frail patients also had axillary surgery omitted compared to non-frail patients (23.5% vs. 11.4%, p < 0.001), as did a greater proportion of patients with a higher CCI (CCI of 0: 11.9% vs. CCI ≥4: 28.5%, p < 0.001). In unadjusted analyses, lower tumor grade (grade 1 vs. grade 3), smaller tumor size (T1a vs T1c), undergoing lumpectomy (vs. mastectomy), and undergoing RT (vs. those who did not) were factors associated with higher rates of axillary surgery omission.

Of the 432 surgeons represented, 52.6% were female, 9.5% identified as surgical oncologists, and 75.5% had >20 years of experience since graduating from medical school (Table 2). The highest quartile of surgeon volume represented a wide range, from thirteen to 41 patients ≥70 with T1N0 HR+/HER2-over the study period. One-hundred thirty-nine (32.3%) surgeons performed axillary surgery on all of their patients. While no surgeons omitted axillary surgery in all patients, 75 (17.4%) omitted axillary surgery in all of their frail patients.

Successive hierarchical logistic regression models to evaluate surgeon-level variation in axillary surgery can be found in Table 3. In the null model, 10.5% of the variance in the axillary evaluation was attributable to the between-surgeon-physician differences. Adjusting for patient frailty, CCI, and chronological age increased between-surgeon variance by only 0.2%, 0.2%, and 2.2% respectively. Adjusting for additional patient-level and surgeon-level covariates did not increase the between-surgeon variance.

Patient factors associated with significantly decreased odds of undergoing axillary surgery included increasing age, increased CCI, and frailty (Table 4). Race, year of diagnosis, income, and urban/rural status were not significantly associated with axillary surgery receipt. Disease-level factors were significant, however, as patients with grade 3 tumors (compared to those with grade 1 tumors), and those with stage T1b or T1c disease (compared to those with stage T1a disease) were more likely to undergo axillary surgery. Significant surgeon-level factors included surgeon-reported sex and specialty, as patients treated by male surgeons and those who identified as general surgeons were more likely to undergo axillary surgery.

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4. Discussion

In this analysis of surgeon-level variation in axillary surgery performed in older females with T1N0 HR+/HER2− breast cancer in the timeframe immediately following the publication of long-term followup of CALGB 9343, between-surgeon differences accounted for a small minority of the variance, leaving a large within-surgeon variation after adjusting for existing covariates in the dataset. Although concerns specific to older adults such as age, comorbidity score, and frailty were significantly associated with receipt of axillary surgery, they explained a small fraction of the variance in our successive modeling. In addition, only a small proportion of surgeons had significantly higher rates of axillary surgery in non-frail, younger (70–74 years), and comorbidity-free patients. In adjusted models, certain disease-level factors such as higher tumor grade and stage, and surgeon-level factors, such as sex and reported specialty, were significantly associated with the likelihood of axillary surgery receipt. However, the sum of our analyses points to significant variation that is not explained by readily available variables in our dataset.

While some surgeons in this analysis were shown to take an “all-or-nothing” approach, as evidenced by the fact that some surgeons performed axillary surgery in all of their patients, the majority of surgeons still displayed some variation in their axillary surgery rates. However, adjusting for patient-level covariates, including those such as chronological age, comorbidities, and frailty, which are significantly associated with lower rates of axillary surgery in past studies [4,5,17,24,25], explained only a very small proportion of the variance. Further adjusting for additional patient and disease-level covariates did not further “explain away” the residual variation. This emphasizes the importance of understanding the effects of unmeasured factors. The surgeons who are not adopting an “all-or-nothing” approach may be offering this as a shared decision with patients, and thus factors such as physician communication skill/style, which are not captured in any large datasets, may be influencing these rates. This would be in line with our qualitative work in this area, in which semi-structured interviews have demonstrated that while some surgeons offer this as a choice, others simply choose to explain why SLNB is not necessary in this patient population [14]. In addition, patient preference can be a strong determinant in treatment receipt, and previous work has demonstrated that some patients are medical minimizers or medical maximizers, having very set opinions regarding the amount of medical interventions they prefer, regardless of health status [26]. Above the level of the patient and physician, there may also be unmeasured factors, such as multidisciplinary atmosphere Our previous work has demonstrated that medical oncology and radiation oncology practice patterns and opinions can influence surgeons’ perspectives on omission of SLNB [14]. The opinions and preferences of these other physicians, the amount of pre-operative communication between specialists, and tumor board discussions (or lack thereof), may all play a role in the within-physician variation seen here.

The surgeon factors associated with a higher likelihood of axillary surgery receipt include identifying as a general surgeon rather than a surgical oncologist. Lack of knowledge has been identified in previous studies as a theme related to lack of SLNB omission [6,14], and perhaps specialty-specific training may aid in this respect. But there may be other issues as well, such as the aforementioned multidisciplinary atmosphere. Previous

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studies have shown improved quality of care with the integration of dedicated specialty-specific surgeons into multidisciplinary cancer care [27–31], with authors emphasizing the importance of building multidisciplinary cancer centers around surgeons. While surgeon volume can be associated with certain quality metrics [32–34], some studies suggest that the relationship between specialization and improved quality is independent of the volume-outcome relationship [29–31]. Our analysis suggests that volume is not significant for this particular practice, reinforcing the idea that specialization may be a highly important factor in de-implementation of low-value care. However, further investigation into evaluating and measuring the effects of these complex network influences on de-escalation practices is needed.

That male sex was also significantly associated with a higher likelihood of axillary surgery is less easily explained. Although one might posit that more recent demographic shifts within surgery may mean that female surgeons represent a more recently-trained cohort, number of years from medical school graduation was not a significant factor. As all patients in this analysis were female, surgeon-patient sex concordance may have played a role in decision-making. Previous studies in other specialties have shown physician-patient gender concordance to be significantly associated with perceptions of communication [35,36] and improved quality of care [37]. However, the roots of this association are beyond the scope of this study and need to be explored in future work.

There are limitations to our work. First, SEER-Medicare may include coding errors in both datasets. The extent of axillary surgery may be unreliably coded in SEER, and upcoding may be present in claims data. However, given the focus of our study on the omission of axillary surgery, our outcome measure could be defined broadly. Second, there are inherent limitations to the variables in this dataset themselves (e.g., income is defined not by the patient but at the level of ZIP code). Third, the generalization of our data may be limited given that we limited our analysis to surgeons to ensure our physician-patient linkages were as accurate as possible, although some gynecologists perform breast surgery in the U.S. Fourth, our study timeframe was chosen to reflect the time immediately following the publication of CALGB 9343. Despite the time that has passed from the study timeframe to the present, SLNB rates in national datasets still, unfortunately, appear to be above 80% [38], which is significantly above what would be expected and only about 5% lower than what it was during our analysis.

5. Conclusions

We have shown that in older female patients with T1N0 HR+ disease, axillary surgery varies more within surgeons than between surgeons. Considerations specific to older adults such as chronologic age, comorbidities, and frailty account for only a small proportion of variance at the physician level. Drivers of the residual within-surgeon variation may include unmeasured factors such as differences in surgeon-patient communication and patient preferences. While these findings are certainly applicable within the field of breast oncology, given the importance of shared decision-making within the realm of deimplementation and the need for nuanced conversations with older adults with complex medical issues, significant future

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work should target factors that usually go unmeasured in large datasets to make significant headway in appropriately tailoring medical care for all older adults with cancer.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

This study used the linked Surveillance, Epidemiology, and End Results (SEER)-Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors. The authors acknowledge the efforts of the National Cancer Institute; Information Management Services (IMS), Inc.; and the SEER Program tumor registries in the creation of the SEER-Medicare database. This project included data from the California Cancer Registry. The collection of cancer incidence data used in this study was supported by the California Department of Public Health pursuant to California Health and Safety Code Section 103885; Centers for Disease Control and Prevention's (CDC) National Program of Cancer Registries, under cooperative agreement 1NU58DP007156; the National Cancer Institute's Surveillance, Epidemiology and End Results Program under contract HHSN261201800032I awarded to the University of California, San Francisco, contract HHSN261201800015I awarded to the University of Southern California, and contract HHSN261201800009I awarded to the Public Health Institute. The ideas and opinions expressed herein are those of the author(s) and do not necessarily reflect the opinions of the State of California, Department of Public Health, the National Cancer Institute, and the Centers for Disease Control and Prevention or their Contractors and Subcontractors.

Funding/Support

This work was supported by the American College of Surgeons Faculty Research Fellowship. Dr. Schonberg's effort was supported by a NIH/NIA K24 (5K24AG071906).

Dr. Minami reports research support (to institution) from the American College of Surgeons (Faculty Research Fellowship, 2020-2023), a Grant for Early Medical/Surgical Specialists' Transition to Aging Research (GEMSSTAR, 2020-2023), a Young Investigator Award from the American Society of Clinical Oncology, and the Beal Fellowship from the Department of Surgery at Brigham and Women's Hospital. Dr. Mittendorf acknowledges support as the Rob and Karen Hale Distinguished Chair in Surgical Oncology.

Role of the Funders/Sponsors

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Declaration of Competing Interest

No authors report financial activities related to the submitted work. CAM reports speaker honoraria for giving grand rounds at Northwell Health, Long Island, NY and speaking at Breast Cancer: New Horizons, Current Controversies presented by the Dana-Farber Cancer Institute. TAK reports speaker honoraria and compensated service on the Scientific Advisory Board of Exact Sciences and personal fees from PrecisCa cancer information service, outside the submitted work. EAM reports compensated service on scientific advisory boards for Astra Zeneca, BioNTech, Merck, and Moderna; uncompensated service on steering committees for Bristol Myers Squibb and Roche/Genentech; speakers honoraria and travel support from Merck Sharp & Dohme; and institutional research support from Roche/Genentech (via SU2C grant) and Gilead. EAM also reports research funding from Susan Komen for the Cure for which she serves as a Scientific Advisor, and uncompensated participation as a member of the American Society of Clinical Oncology Board of Directors. All other authors report no disclosures or conflicts of interest.

Data Availability

The datasets used to conduct this study are available upon approval of a research protocol from the National Cancer Institute. Instructions for obtaining these data are available at: https://healthcaredelivery.cancer.gov/seermedicare/obtain/.

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Table 1

Patient characteristics.

	Axillary surgery (*N* = 3796, 86.1%)	No axillary surgery (*N* = 614, 13.9%)	*p*-value
Age (years)			<0.001
70–74	1761 (96.3)	68 (3.7)	
75–79	1196 (91.2)	116 (8.8)	
80–84	588 (74.2)	204 (25.8)	
≥85	251 (52.6)	226 (47.4)	
Frail			<0.001
Yes	700 (76.5)	215 (23.5)	
No	3096 (88.6)	399 (11.4)	
Charlson Comorbidity Index			<0.001
0	2752 (88.1)	371 (11.9)	
1	569 (84.3)	106 (15.7)	
2	276 (80.9)	65 (19.1)	
3	111 (75.0)	37 (25.0)	
≥4	88 (71.5)	35 (28.5)	
Race and Ethnicity			0.55
African-American/Black	155 (88.6)	20 (11.4)	
Hispanic/Latinx White	143 (83.6)	28 (16.4)	
Non-Hispanic/Latinx White	3337 (86.2)	535 (13.8)	
Other/Unknown[a]	161 (83.4)	31 (16.1)	
Year of Diagnosis			0.23
2013	1312 (87.3)	191 (12.7)	
2014	1312 (85.3)	227 (14.7)	
2015	1172 (85.7)	196 (14.3)	
Median income			
Quartile 1 (lowest)	396 (87.4)	57 (12.6)	0.44
Quartile 2	688 (85.2)	120 (14.9)	
Quartile 3	1024 (87.1)	152 (12.9)	
Quartile 4 (highest)	1688 (85.6)	285 (14.5)	
Urban/Rural status			
Urban	845 (82.6)	178 (17.4)	0.001
Rural	150 (87.2)	22 (12.8)	
Unknown	2801 (87.1)	414 (12.9)	
SEER Region			<0.001
West	1719 (86.6)	266 (13.4)	
Northeast	792 (80.4)	193 (19.6)	
Midwest	438 (89.2)	53 (10.8)	
South	847 (89.3)	102 (10.8)	
Tumor Grade			0.03
1	1560 (85.4)	266 (14.6)	

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	Axillary surgery (*N* = 3796, 86.1%)	No axillary surgery (*N* = 614, 13.9%)	*p*-value
2	1826 (85.8)	302 (14.2)	
3	334 (91.3)	32 (8.7)	
Unknown	76 (84.4)	14 (15.6)	
Tumor Stage			0.01
T1a	477 (82.2)	103 (17.8)	
T1b	1363 (86.3)	216 (13.7)	
T1c	1956 (86.9)	295 (13.1)	
Histology			0.04
IDC	2850 (86.7)	438 (13.3)	
ILC	573 (85.7)	96 (14.4)	
Other	373 (17.7)	80 (17.7)	
Breast Surgery			<0.001
Lumpectomy	3103 (84.3)	580 (15.8)	
Mastectomy	693 (95.3)	34 (4.7)	
Radiation Therapy			<0.001
Yes	2100 (92.0)	183 (8.0)	
No	1696 (79.7)	431 (20.3)	

Abbreviations: SEER: Surveillance, Epidemiology, and End Results; IDC: invasive ductal carcinoma; ILC: invasive lobular carcinoma.

[a]Other ethnicity: patients coded as American Indian, Chinese, Japanese, Filipino, Hawaiian, Korean, Vietnamese, Laotian, Hmong, Kampuchean, Thai, Asian Indian, Pakistani, Micronesian, Chamorran, Guamanian, Polynesia, Tahitian, Samoan, Tongan, Melanesian, Fiji Islander, New Guinean, Other Asian Not Otherwise Specified (NOS), Pacific Islander NOS, or Other in SEER. Unknown ethnicity: patients coded as Unknown in SEER.

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Table 2

Surgeon characteristics (*n* = 432).

Reported sex	**n (%)**
Female	205 (52.6)
Male	227 (47.5)
Volume over Study Period	
Quartile 1 (5 cases)[a]	82 (19.0)
Quartile 2 (6–8 cases)	146 (33.8)
Quartile 3 (9–12 cases)	99 (22.9)
Quartile 4 (13–41 cases)	105 (24.3)
Practice Region	
Northeast	91 (21.1)
Midwest	51 (11.8)
South	107 (24.8)
West	183 (42.4)
Surgical Specialty	
General Surgery	391 (90.5)
Surgical Oncology	41 (9.5)
Years since Medical School Graduation	
<20	105 (24.4)
20–29	157 (36.3)
30–39	132 (30.6)
≥40	38 (8.8)

[a]Surgeons who did <5 cases over the study period in this patient population were excluded.

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Table 3

Successive hierarchical logistic regression models with intracluster correlations.

	ICC (between-surgeon variance)	1-ICC (within-surgeon variance)
Null Model[a]	0.1081	0.8919
Model 2: Adjusted for frailty	0.1104	0.8898
Model 3: Adjusted for age	0.1300	0.8700
Model 4: Adjusted for CCI	0.1102	0.8896
Model 5: Adjusted for frailty, CCI, and age	0.1326	0.8670
Model 6: Adjusted for all patient-level covariates[b]	0.1237	0.8763
Model 7: Adjusted for patient-level and surgeon-level covariates[c]	0.1204	0.8796

Abbreviations: ICC: intracluster correlation; CCI: Charlson Comorbidity Index.

[a]Model run with random physician intercepts without other covariates.

[b]Patient-level covariates include: frailty, CCI, age, race and ethnicity, income, Surveillance, Epidemiology, and End Results (SEER) region, urban/rural status, tumor grade, tumor stage, breast surgery type, and radiation therapy.

[c]Surgeon-level covariates include: reported sex, case volume, practice region, surgical subspecialty, years since medical school graduation.

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Table 4

Adjusted logistic regression predicting receipt of axillary surgery in patients ≥70 years of age or older with T1N0 H+ breast cancer.[a]

	Odds ratio [95% CI]
Age (years)	
70–74	REF
75–79	**0.40 [0.30–0.52]**
80–84	**0.12 [0.09–0.15]**
≥85	**0.04 [0.03–0.05]**
Frailty	
No	REF
Yes	**0.66 [0.54–0.81]**
Charlson Comorbidity Index	
0	REF
1	0.92 [0.72–1.17]
2	**0.69 [0.51–0.93]**
3	**0.58 [0.39–0.87]**
≥4	**0.62 [0.39–0.97]**
Race and Ethnicity	
African-American/Black	1.35 [0.87–2.08]
Hispanic/Latinx White	0.78 [0.52–1.18]
Non-Hispanic/ Latinx White	REF
Other	0.76 [0.49–1.16]
Unknown	1.66 [0.50–5.53]
Year of Diagnosis	
2013	REF
2014	0.82 [0.66–1.01]
2015	0.92 [0.74–1.12]
Median income	
Quartile 1	REF
Quartile 2	0.83 [0.61–1.15]
Quartile 3	1.00 [0.73–1.37]
Quartile 4	0.96 [0.70–1.31]
Urban/Rural status	
Urban	REF
Rural	0.91 [0.57–1.48]
Unknown	1.10 [0.83–1.46]
Tumor Grade	
1	REF
2	1.10 [0.92–1.32]
3	**1.49 [1.04–2.14]**
Tumor Stage	

	Odds ratio [95% CI]
T1a	REF
T1b	**1.78 [1.37–2.31]**
T1c	**1.91 [1.48–2.46]**
Physician Reported Sex	
Female	**REF**
Male	**1.52 [1.20–1.93]**
Physician Volume	
Quartile 1 (5 cases)	REF
Quartile 2 (6–8 cases)	1.23 [0.80–1.90]
Quartile 3 (9–12 cases)	1.30 [0.90–1.89]
Quartile 4 (13–41 cases)	1.40 [1.00–2.03]
Physician Region	
Northeast	0.30 [0.09–1.00]
Midwest	0.41 [0.07–2.46]
South	0.68 [0.17–2.72]
West	REF
Physician Specialty	
General Surgery	REF
Surgical Oncology	**0.67 [0.47–0.95]**
Years Since Medical School Graduation	
<20	1.05 [0.69–1.59]
20–29	1.02 [0.70–1.50]
30–39	1.05 [0.71–1.53]
≥40	REF

Abbreviations: H+: hormone receptor-positive; CI: confidence interval.

[a] Other ethnicity: patients coded as American Indian, Chinese, Japanese, Filipino, Hawaiian, Korean, Vietnamese, Laotian, Hmong, Kampuchean, Thai, Asian Indian, Pakistani, Micronesian, Chamorran, Guamanian, Polynesia, Tahitian, Samoan, Tongan, Melanesian, Fiji Islander, New Guinean, Other Asian Not Otherwise Specified (NOS), Pacific Islander NOS, or Other in SEER. Unknown ethnicity: patients coded as Unknown in SEER.

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