Physician Practice Volume and Alternative Surgical Treatment for Breast Cancer in Florida

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Objective. To determine whether surgeon procedure volume is related to the selection of a surgical option (mastectomy versus breast-conserving surgery) for breast cancer treatment.

Study Setting/Study Design. Secondary data sources were used to study surgical procedures performed for female breast cancer in Florida during the years 1997–98 in a retrospective population-based analysis.

Data Extraction. Surgical procedures for female breast cancer in Florida were identified during 1997 and 1998 (N = 28,380) by combining data from the Florida Acute Hospital and Short-term Psychiatric Inpatient Data Collection and the Ambulatory Outpatient Data Collection. A total of 1,320 physicians who provided breast surgical procedures in Florida during the two-year study period were identified.

Principal Findings. After controlling for selected patient and physician characteristics, the lowest volume surgeons were nearly twice as likely to perform mastectomies rather than breast-conserving surgery compared with the highest volume group. Patients with Medicaid as an insurer were also nearly twice as likely to receive mastectomies. Patient demographic factors such as age, while statistically significant, were shown to be far less predictive of procedure choice. Forty-two percent of the physicians performed fewer than two surgeries on average per year.

Conclusions. Patients treated by lower volume physicians have a greater likelihood of receiving mastectomies than do those patients treated by higher volume physicians.

Key Words. Breast cancer, breast-conserving surgery, surgical practice volume

INTRODUCTION

Since first being described more than 20 years ago (Luft, Bunker, and Enthoven 1979) the association between higher volumes of surgery and improved surgical outcomes has been widely documented (Begg et al. 1998; Hannan, Kilburn, Bernard, et al. 1991; Potosky and Warren 1999). Outcome measures studied include in-hospital mortality, 30-day mortality, long-term survival, complication rates, hospital length of stay, and cost of care, as well as clinical process outcomes such as

the use of specific procedures. Most of these studies focus on the relationship between hospital volume and outcomes, whereas fewer investigate relationships between individual physician volume and outcomes.

Breast cancer is the most common cancer in women in the United States, accounting for an estimated 175,000 new cases in 1999. While treatment for breast cancer may include multiple modalities (surgery, radiation therapy, chemotherapy), the vast majority of patients receive some form of surgical procedure (American Cancer Society 2000). However, there have been relatively few studies applying traditional outcome measures to the study of breast cancer surgery volume. Two studies from the United Kingdom have been reported. Sainsbury, Haward, Rider, et al. (1995) reported improved five-year survival among patients of surgeons treating 30 or more breast cancer patients per year versus those treating fewer than 30 cases per year. Gillis and Hole (1996) described improved five-year survival for patients treated by specialists (surgeons emphasizing treatment of breast cancer in their practice) compared with those treated by nonspecialists after adjusting for patient age, socioeconomic status, tumor size, and nodal involvement.

Outcome studies from the United States have focused on the relationship between hospital volume and breast cancer surgery. Two large studies have been reported. The first study, of 5,892 white women treated between 1984 and 1990 in Southern California hospitals, found that the highest five-year survival rates, regardless of method of surgery, were found in the large community hospitals (Lee-Feldstein, Anton-Culver, and Feldstein 1994). In another study Roohan, Bickell, Baptize, et al. (1997) linked hospital discharge data with data from a regional tumor registry over a five-year period to include nearly 50,000 patients hospitalized at 266 hospitals. After adjusting for covariates, being treated at higher volume hospitals was associated with a 19 percent to 60 percent improvement in survival.

More commonly researchers have studied the increasing use of breast-conserving surgery (BCS) as a process outcome indicating quality surgical care in

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breast cancer. In 1990 the National Institutes of Health (NIH) convened a consensus conference to evaluate, among other treatment issues, the available scientific information about the safety and efficacy of BCS. This conference identified BCS as the preferable method of primary therapy for women with stage I and II breast cancer because it provides survival rates equivalent to mastectomy while preserving the breast. The conferees concluded that while some women have clinical criteria that make BCS inappropriate, the procedures were indicated in the majority of stage I and II patients (NIH Consensus Conference 1991).

The use of BCS increased steadily throughout the United States from 1990 to 1995, although the rate of growth was found to vary across regions and by stage of disease, with rates of utilization for women with stage II disease lower than for those with stage I disease (Lazovich, Solomon, Thomas, et al. 1999). Studies have shown greater use of BCS to be associated with hospital characteristics such as teaching affiliation, larger size, on-site radiation therapy facilities, and urban location.

There has also been an increasing tendency to provide surgery for breast cancer in the ambulatory care setting. Studies have shown that breast surgery can be successfully conducted in the ambulatory care setting (Coady, Benson, and Hartley 1993; Tan and Guenther 1997). It has been further demonstrated that clinical and psychologic outcomes for ambulatory surgery are similar to or better than those experienced by hospitalized patients (Margolese and Lasry 2000).

The objective of this study was therefore to determine whether the surgical caseload volume of the individual physician was consistently associated in some way with the type of surgical procedure provided (i.e., mastectomy vs. BCS). The study population of surgical procedures included merged inpatient and outpatient data, providing for the first time a unique description of the relationship among individual surgeon volume, surgical procedure, and site of surgery.

METHODS

Data Sources and Synthesis

The current study capitalizes on the recent availability of ambulatory care data for surgical procedures in Florida by combining information from the inpatient and outpatient settings for breast cancer. Surgical procedures for female breast cancer in Florida were identified during 1997 and 1998 (N = 28,380) by combining data from the Florida Acute Hospital and Short-term Psychiatric Inpatient Data Collection and the Ambulatory Outpatient Data Collection. Hospitals and ambu-

latory surgical facilities in the state of Florida are required by law to submit data on all discharges to the Florida Agency for Health Care Administration, where the data are verified and combined into data file inpatient and ambulatory care files. While no patient identifiers are included in these files, each record has a unique identifier for operating physician and facility.

All records including the diagnosis codes for primary breast cancer (International Classification of Diseases, Ninth Revision, Clinical Modifications [ICD-9-CM] diagnosis codes 174.0–174.9, 196.3, 198.81, and 233.0) were identified. Next, cases with surgical procedures were identified for the final dataset. All cases with ICD-9-CM procedure codes 85.20 to 85.23 and 85.41 to 85.48 were included from the inpatient data, while all cases with current procedural terminology (CPT) codes 19120, 19125, 19126, 19160, 19162, 19180, 19182, 19200, 19220, and 19240 were included from the outpatient data.

A total of 1,320 physicians who provided breast surgical procedures in Florida during the two-year study period were identified. Physicians were rank ordered according to their total volume of surgical practice (physician performing the lowest number of procedures to the physician performing the highest number of procedures) and then classified into volume categories for the purpose of this analysis. As the first step, the physicians were placed into five groups by identifying cut points at the 20th, 40th, 60th, and 80th percentiles (quintiles). However, because the distribution of physician volume was L shaped, with the modal value of one case per physician and a highly positively skewed distribution, the fifth group was split at the 90th percentile, resulting in six categories. The volume categories included “single case” (one case), “very low volume” (two to six cases), “low volume” (seven to 17 cases), “medium volume” (18 to 35 cases), “high volume” (36 to 52 cases), and “very high volume” (53 to 435 cases) during the two-year period. Further information about the volume groups is provided in Table 1.

Demographic information on the physicians in the study was abstracted from the American Medical Association’s Directory of Physicians in the United States. Variables available for 75 percent or more of the physicians in the study included years in practice (estimated by calculating the length of time since graduation from medical school), self-reported board certification status, and whether the physician had graduated from a medical school outside of the United States or Canada. The majority (60–75 percent) of the missing demographic values occurred for physicians from the two lowest volume groups.

Patient demographic information was available for 97 percent or more of the cases. Demographic data for the patients included age, race (collapsed to

Table 1: Description of Physician Volume Categories, 1997–98*

	Single Case (n = *312*)	*Very Low* (n = *246*)	*Low* (n = *258*)	*Medium* (n = *245*)	*High* (n = *127*)	*Very High* (n = *131*)
Cumulative percentile rank†	24	42	62	80	90	100
Total cases–*N* (%)	312 (1)	873 (3)	3,107 (11)	6,266 (22)	5,532 (20)	12,290 (43)
Range of cases	NA	2–6	7–17	18–35	36–52	53–435
Median	NA	4	13	27	44	191
Mean	1	4	12	26	44	94
Annualized mean	1	2	6	13	22	47

*Rounded to nearest whole number.
†Cut points for groups made at nearest whole number.

white vs. nonwhite), payer type (collapsed to commercial insurance, Medicare, Medicaid, and other), and percent population living in a rural setting (percent rurality). Rurality was defined as the percentage of the population in a county that lived outside of an urbanized area (population of at least 2,500).

Data Analysis

First, a series of unadjusted bivariate analyses was conducted to compare volume categories with physician and patient demographic characteristics. Next, the surgical procedure provided by the physicians (mastectomy/BCS) by site of treatment (inpatient/ambulatory care) was compared across the volume categories. Chi-square tests for differences in proportions were used to compare categoric dependent variables, while one-way analysis of variance (ANOVA) was employed to test for difference in continuous dependent variables. Conventional nominal levels for alpha ($p \leq .05$) were adjusted using the modified Bonferroni approach to adjust for potential inflation of experiment-wise alpha because of multiple statistical inferences (Holland and Copenhaver 1988). Significant ANOVA were followed with pairwise *t*-tests, also adjusted for multiple comparisons. Finally, a multivariate (logit link) model employing generalized estimating equations (GEE) was developed, with the use of mastectomy treated as the dependent variable and the volume categories and demographic variables as explanatory variables. GEE controls for nonindependence among patients treated by individual physicians and provides for efficient estimates of the coefficients and improved

standard error estimates with clustered data (Diggle, Liang, and Zeger 1994). All data analyses were conducted using SAS software (SAS Institute, Inc.) version 8.1.

RESULTS

Demographics

Table 2 describes the results of the demographic analysis. The percentage of physicians who were board certified increased across the volume categories from 79 percent for single case physicians to 98 percent for very high volume physicians. This relationship was statistically significant: χ^2 (5, n = 988) = 29.2, $p < .001$. Very low volume physicians were most likely to have graduated from foreign medical schools (41 percent), whereas very high volume physicians were least likely to have graduated from a medical school outside of the United States or Canada (14 percent). Differences in proportions of physicians graduating from medical school outside of the United States or Canada were statistically significant: χ^2 (5, n = 1,031) = 23.9, $p < .001$. Mean years in practice for the volume categories ranged from 22 for very high volume physicians to 25 years for very low volume physicians. These differences were not statistically significant: F (5, n = 1,025) = 1.45, $p = .20$.

Table 2 also describes the patient demographic variables by physician volume category. Mean patient age ranged between 62 (standard deviation [s.d.] = 15) and 64 (s.d. = 14) years. There was a statistically significant difference for mean age between volume categories based on one-way ANOVA: F (5, n = 28,373) = 15.33, $p < .001$. Post hoc comparisons of group means found that patients treated by physicians in the single case, very low, and very high volume groups were significantly younger than patients treated by physicians in the low, medium, and high volume groups, although the actual differences in years was very small: t (28,373) > 2.94, $p < .05$. Mean values for rurality of the county in which the patient lived ranged from 14 (s.d. = 19) for the very high volume group to 21 (s.d. = 24) for the low volume group. There was also a statistically significant difference between volume categories based on one-way ANOVA—F (5, n = 28,380) = 84.16, $p < .001$—based on level of rurality. Post hoc comparisons found that patients treated by physicians in the low volume group had higher mean rurality scores than all of the other groups; patients treated by physicians in the very low and medium volume groups had higher mean rurality scores than patients treated by the high and very high volume groups: t (27,853) > 2.94, $p < .05$. The percentage

Table 2: Physician and Patient Demographic Variables by Volume Categories*

	Single Case	*Very Low*	*Low*	*Medium*	*High*	*Very High*
Patient Characteristics						
Age[a]–mean (standard deviation)	63 (14)	62 (15)	64 (14)	64 (14)	64 (14)	63 (14)
Race[b] (%)						
White	82	81	85	86	89	89
Nonwhite	17	19	15	14	11	11
Rurality[c]–mean (standard deviation)	15 (21)	17 (23)	21 (24)	18 (22)	14 (17)	14 (14)
Payer[b] (%)						
Commercial	45	41	38	41	45	46
Medicare	38	40	50	48	48	44
Medicaid	5	7	4	3	2	2
Other	12	12	8	8	6	8
Physician Characteristics						
Board certified[d] (%)	79	80	83	88	91	98
Foreign medical graduate[e] (%)	30	41	32	31	32	14
Years in practice[d]–mean (standard deviation)	23 (11)	25 (11)	24 (11)	24 (10)	24 (8)	22 (8)

*Rounded to nearest whole number.
[a]Single case (n = 311), very low volume (n = 873), low volume (n = 3,107), medium volume (n = 6,266), high volume (n = 5,532), very high volume (n = 12,290).
[b]Single case (n = 312), very low volume (n = 873), low volume (n = 3,107), medium volume (n = 6,266), high volume (n = 5,532), very high volume (n = 12,290).
[c]Single case (n = 304), very low volume (n = 859), low volume (n = 3,062), medium volume (n = 6,159) high volume (n = 5,445), very high volume (n = 12,030).
[d]Single case (n = 184), very low volume (n = 170), low volume (n = 206), medium volume (n = 209), high volume (n = 112), very high volume (n = 107).
[e]Single case (n = 188), very low volume (n = 176), low volume (n = 217), medium volume (n = 215), high volume (n = 116), very single high volume (n = 119).

of patients who were nonwhite was found to be highest in the very low volume (19 percent) and single case (18 percent) groups and lowest in the high volume (11 percent) and very high volume (11 percent) groups. This relationship was statistically significant: χ^2 (5, n = 28,380) = 102.85, p < .0001. Finally, the percentage of patients reporting Medicaid as their primary payer source was found to be highest in the very low volume (7 percent) and single case (5 percent) groups and lowest in the high volume (2 percent) and very high volume (2 percent) groups. Differences in payer type among volume groups were statistically significant: χ^2 (15, n = 28,380) = 102.85, p < .001.

Practice Volume, Type of Surgery, and Location of Practice

Table 3 describes the type of surgery (mastectomy/BCS) performed by the location of the surgery (inpatient/ambulatory care) across the six volume categories. It is first important to note that the majority of breast surgery in Florida is currently performed in the ambulatory care setting (63 percent). Next, it is clear that, independent of location of surgery, the likelihood of receiving BCS increased for patients treated by higher volume physicians, with fewer than 50 percent of the patients in the single case and very low volume groups receiving BCS and 62 percent of patients treated by the very high volume group receiving BCS. This relationship was statistically significant: χ^2 (5, n = 28,380) = 266.9, $p < .001$. However, when comparing the utilization of BCS/mastectomy by location of surgery only patients treated by physicians in the single case group were more likely to receive BCS in the inpatient setting (31 percent) than were patients treated by physicians in the other groups (range 17 percent to 20 percent): χ^2 (5, n = 10,367) = 38.2, $p <$ .001. Location of surgery procedure for all other groups was nonsignificant.

Table 3: Surgical Procedures (%) for Female Breast Cancer in Florida, 1997–98 by Physician Volume Category (N = 28,380)*

Volume	*Inpatient*	*Ambulatory*	*Total*†
Single case			
BCS (n = 151)	31‡	72	48
Mastectomy (n = 161)	69	28	52
Very low			
BCS (n = 410)	19	80	47
Mastectomy (n = 463)	81	20	53
Low			
BCS (n = 1,562)	17	79	50
Mastectomy (n = 1,545)	83	21	50
Medium			
BCS (n = 3,394)	17	80	54
Mastectomy (n = 3,472)	83	20	46
High			
BCS (n = 3,286)	20	82	59
Mastectomy (n = 2,246)	80	18	41
Very high			
BCS (n = 7,656)	21	81	62
Mastectomy (n = 4,634)	79	19	38
Total	37	63	100

*Rounded to nearest whole percent.
†Chi-square test for BCS/mastectomy by volume groups $p < .001$.
‡Chi-square test for BCS/mastectomy by treatment setting within volume groups $p < .001$.

Multivariate Analysis

To further explore the relationship among physician volume, physician demographics, patient demographics, and choice of surgical procedure for breast cancer, a multivariate (logit link) model employing GEE was developed. Patient data were nested within physician for the analysis. A dummy variable for the use of mastectomy was chosen for the dependent variable to simplify the interpretation of regression coefficients. Dummy variables were also created for each of the physician volume categories, with the very high volume category being omitted (used as reference group), and for the primary payer groups (Medicare and Medicaid, with commercial insurance as the reference group), board certification status of the physician, and foreign medical school graduate status. Patient age, rurality, and physician years since graduation from medical school were included in the model as continuous predictor variables.

None of the physician demographic variables proved to be significant or to affect the relationships among predictor variables in preliminary models and were eliminated from the final reported model. Because the relationship between age and the use of mastectomy was found to be curvilinear, a squared age variable was also included in the model. Results of this analysis are provided in Table 4.

Patients treated by single case and very low volume physicians were almost twice as likely as patients treated by very high volume physicians to receive a mas-

Table 4: Multivariate Model Employing Generalized Estimating Equations Predicting the Use of Mastectomy*

Variable	*Odds Ratio*	*95% Confidence Interval*	p-*value*
Single case	1.78	1.39–2.27	< .001
Very low volume	1.79	1.48–2.18	< .001
Low volume	1.55	1.34–1.79	< .001
Medium volume	1.35	1.17–1.54	< .001
High volume	1.10	0.95–1.27	.19
Patient age	0.95	0.94–0.97	< .001
Patient age^2	1.00	1.00–1.00	< .001
White race	1.12	1.02–1.25	.02
Medicare	1.17	1.08–1.26	< .001
Medicaid	1.70	1.45–1.99	< .001
Rurality	1.00	1.00–1.01	< .001

*Model fit (deviance = 37412.7, n = 27,859).

tectomy. With increasing volume the odds of receiving a mastectomy lessened, with patients of low volume physicians being about one and one half times as likely to receive a mastectomy and those of medium volume physicians being about one and one third times as likely to receive a mastectomy. Only for the high volume physician group (those performing 36 to 52 cases during the study period) was volume not found to be significant. Medicaid patients were found to be more than one and one half times as likely to have mastectomies as persons with commercial insurance, whereas those with Medicare were approximately 20 percent more likely to receive mastectomies. However, other patient characteristics (race, age, and rurality) were less predictive of mastectomy use, even though age and rurality were statistically significant.

DISCUSSION

We found that nearly two-thirds of the breast surgeries in Florida during the study period were performed in the ambulatory care setting (n = 18,012); this includes more than one in five (22.7 percent, n = 3,509) of all mastectomies performed. Our results indicate that studies of physician volume for breast cancer that do not include ambulatory care data would vastly underestimate the true nature of the activity.

In our data BCS has become the most common surgical treatment for breast cancer, with 16,459 (58.0 percent) of the procedures conducted. This is consistent with the study conducted by Lazovich, Solomon, Thomas, et al. (1999), which demonstrated the increased use of BCS among stage I and stage II breast cancer patients between 1983 and 1995. Unfortunately the data sources used in the current study did not include the stage of disease, which makes direct comparisons impossible. However, because BCS is used less often in late-stage breast cancers it is likely that the use of BCS would be higher if the analysis were restricted to early-stage cancers.

It is also important to note that the current study reports discharge data and not patient-level data. Physicians may perform a BCS procedure in one discharge and then perform a second procedure because of factors such as positive surgical margins in a second discharge (either BCS or mastectomy). We believe this practice is uncommon with the development of interoperative pathology procedures combined with immediate re-excision of positive margins (Sauter, Hoffman, Ottery, et al. 1994). However, the current data do not provide the ability to confirm our beliefs. To the extent that re-excision occurs in a second admission, results in

the current study may differ from a patient-based study. Patient-based studies would be expected to find lower physician practice volumes and a different ratio of BCS to mastectomy performed depending on the type of procedure that is conducted in the second admission.

While physician volume and both patient and physician demographic characteristics were positively associated with type of surgical procedure in the bivariate analysis, only physician volume and patient demographic characteristics remained significant in multivariate analysis. All three of the physician demographic characteristics were found not to be statistically significant in the multivariate model. This might have been due to our limited access to physician demographic data or possibly to correlations between the independent variables included. To investigate whether this could be the result of correlation between physician demographic variables and the volume categories, we tested for (and found no evidence of) the presence of multicollinearity in the full model. This gives additional support to the hypothesis that surgical volume is directly related to the procedure used.

The patient demographic characteristics that demonstrated the strongest association with the use of mastectomy in the multivariate model were Medicaid followed by Medicare as a type of payer. While patient age and living in a more rural county demonstrated statistically significant associations with the use of mastectomy, the actual differences in the model were very small. These results are consistent with a national study by McGinnis, Menck, Harmon, et al. (2000) that found breast cancer patients from lower income zip codes to be older, diagnosed at later stage of disease, and less likely to receive BCS than patients from higher income zip codes.

It is likely that lower BCS utilization among older, poorer, and rural patients is a result of a combination of financial, logistic, and perhaps cultural factors. This might be more prevalent in a state like Florida that has a large population of retirees, many of whom live in rural areas, while radiation therapy facilities tend to be located in urban areas. While further research regarding the exact nature of these relationships seems warranted, it is important to remember that the current study found a highly significant association to physician volume after adjusting for a number of patient demographic variables.

Clearly, variables not included in this study may affect the use of BCS. In some cases BCS may not be an option based on patient clinical variables. The most important clinical variable that may exclude the use of BCS is the stage of disease. Patients with late-stage disease are often not eligible for BCS. Other contraindications are related to size and location of the tumor, which might lead to

poor cosmetic outcome with BCS (Margolese 1999). In addition, comorbid conditions have been shown to be associated with later stage detection of breast cancer (Gonzalez, Ferrante, Van Durme, et al. 2001), which in turn would increase the likelihood of mastectomy. Efforts to obtain data including stage of disease should be made.

The two studies of the association between surgical volume and breast cancer outcome previously reported in the United States focused on the association of "hospital volume" with mortality for breast cancer (Lee-Feldstein, Anton-Culver, and Feldstein 1994; Roohan, Bickell, Baptize, et al. 1997). We focus here on the association between physician practice volume for breast cancer and the use of BCS as process measure of quality care.

By combining data from inpatient and ambulatory care databases we included a heterogeneous combination of freestanding (outpatient only) and hospital surgery facilities (inpatient and ambulatory care), some of which provide only BCS or only mastectomy while others provide both. A discussion of how breast surgical volume at these facilities might affect the utilization is beyond the scope of the present analysis. As a preliminary analysis we have, however, calculated a total facility frequency score for all of the facilities in the study. The total facility frequency score ranged from one procedure to 936 (n = 254, mean = 294.9, s.d. = 236.5). We then assigned the total facility frequency score and a total physician frequency score to each case and calculated a Pearson correlation coefficient. The results of this analysis were positive (r = 0.44, n = 25,750, $p < .0001$), indicating that higher volume physicians were more likely to practice in higher volume facilities.

In a recent review by Hillner, Smith, and Desch (2000) nearly 40 published studies of the effect of surgical volume on cancer outcomes were identified. Breast cancer surgeries, which were described as being of "low" perioperative surgical risk, accounted for relatively few outcome studies. Perhaps it is the conception of breast surgery as being low risk that establishes an environment in which the majority of physicians feel comfortable performing a procedure even though they only perform the procedure once every other month. Over the last decade the utilization of BCS has been seen as a proxy for quality surgical care for breast cancer. To the extent that BCS use is a valid measure of the appropriate treatment of breast cancer, patients treated by low volume physicians are at a higher risk for receiving less-than-optimal care.

A recent National Cancer Policy Board white paper on the relationship between volume and outcomes for cancer states that volume is an important but imperfect correlate of quality. Volume is an easily obtained proxy measure for other

factors of care including physician skill, experienced multidisciplinary teams, and well-organized care processes. The report suggests that currently the literature sheds little light on the structures and processes that underlie this relationship (Hewitt and Petitti 2001). Expanding studies to include multiple outcome measures and combine clinical data with administrative data (particularly for high volume procedures) should be the next step. Results of the current study suggest that surgical treatment procedure and physician practice volume for breast cancer might provide an excellent model for this type of study. Armed with this more completed understanding of the relationship, policymakers would be able to provide consumers with important information in making choices for care.

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