Location Isn't Everything: Proximity, Hospital Characteristics, Choice of Hospital, and Disparities for Breast Cancer Surgery Patients

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Objective. Assess the relative importance of proximity and other hospital characteristics in the choice of hospital for breast cancer surgery by race/ethnicity.

Data. SEER-Medicare data.

Study Design. Observational study of women aged >65 years receiving surgery for stage I/II/III breast cancer diagnosed in 1992–2007 in Detroit ($N = 10,746$ white/black), Atlanta ($N = 4,018$ white/black), Los Angeles ($N = 9,433$ white/black/Asian/Hispanic), and San Francisco ($N = 4,856$ white/black/Asian). We calculated the distance from each patient's census tract of residence to each area hospital. We estimated discrete choice models for the probability of receiving surgery at each hospital based on distance and assessed whether deviations from these predictions entailed interactions of hospital characteristics with the patient's race/ethnicity. We identified high-quality hospitals by rates of adjuvant radiation therapy and by survey measures of patient experiences, and we assessed how observed surgery rates at high-quality hospitals deviated from those predicted based on distance alone.

Principal Findings. Proximity was significantly associated with hospital choice in all areas. Minority more often than white breast cancer patients had surgery at hospitals with more minority patients, those treating more Medicaid patients, and in some areas, lower quality hospitals.

Conclusions. Residential location alone does not explain concentration of racial/ethnic-minority breast cancer surgery patients in certain hospitals that are sometimes of lower quality.

Key Words. Breast cancer, surgery, health care disparities, hospital racial composition, distance

Racial and ethnic disparities in the delivery and utilization of health care in the United States have been well documented (Jha et al. 2005; Trivedi et al. 2005). Recent research suggests that racial disparities in health care may be driven in

part by differences in where minority patients obtain care. Black patients are more likely to receive care in lower performing hospitals (Barnato et al. 2005; Skinner et al. 2005; Liu et al. 2006; Lucas et al. 2006; Hasnain-Wynia et al. 2007; Jha et al. 2007) and to be treated by physicians that are less well trained and have less access to important clinical resources than those treating white patients (Bach et al. 2004). Even when black patients reside closer to lower mortality hospitals, they are admitted more often to high-mortality hospitals than white patients, suggesting that factors other than geographic proximity drive racial differences in hospital use (Sarrazin, Campbell, and Rosenthal 2009). A recent study found that black patients were more likely than whites to undergo three high-risk surgical procedures at low-quality hospitals, despite tending to live closer to high-quality hospitals (Dimick et al. 2013).

We previously documented that black women diagnosed with early-stage breast cancer were more likely than white women to undergo breast cancer surgery at hospitals with lower rates of radiation following breast-conserving surgery (Keating et al. 2009) and that this explains some of the racial disparities in receipt of definitive primary therapy for early-stage breast cancer. We also observed that a small number of hospitals treated the majority of black patients: 81 percent of black patients had surgery at 17 percent (82/481) of the hospitals.

Relatively little is known about how patients choose hospitals for surgery or how this choice differs by race/ethnicity. In addition, relatively little is known about location of care for non-black minority patients. In this study, we used data from a large cohort of women with early-stage breast cancer residing in one of four geographically distinct urban areas to assess the roles of the hospital's proximity to their home and other factors in their choice of hospital for breast cancer surgery. Specifically, we estimated discrete choice models for the selection of the surgical hospital as a function of distance. We then assessed whether deviations from these predictions for patients of different racial/ethnic subgroups (including black, Asian, and Hispanic patients)

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varied by hospital characteristics, including racial/ethnic composition of all hospital discharges, the proportion of Medicaid discharges, and the availability of a residency program or onsite radiation therapy. We also assessed whether measures of quality at hospitals where minority patients obtained breast cancer surgery differed from those for white patients, and whether such differences were explained by proximity.

METHODS

Data

We analyzed Surveillance, Epidemiology, and End Results (SEER)-Medicare data (Potosky et al. 1993) from four SEER regions with sizable minority populations (Detroit, Atlanta, San Francisco/San Jose, and Los Angeles County). The SEER program of the National Cancer Institute collects uniformly reported data from population-based cancer registries currently representing 28 percent of the population (Warren et al. 2002). For each incident cancer, the SEER registries collect information on month and year of diagnosis, cancer site, histological type, cancer stage, and patient demographic characteristics. Since 1991, the NCI has linked SEER data with Medicare administrative data for more than 94 percent of SEER registry patients diagnosed at age 65 or older (Potosky et al. 1993).

We characterized the racial composition of each hospital's patient discharges, using the 5 percent Medicare claims files for beneficiaries living in these SEER areas. Measures of hospital quality based on patient reports were obtained from the 2007 Hospital Consumer Assessment of Health Care Providers and Systems (HCAHPS) survey, publicly reported by the Center for Medicare and Medicaid Services. This standardized survey instrument measures patients' experiences with hospital care, allowing comparisons to be made across hospitals. The publicly available HCAHPS survey data include six composite measures (communication with doctors, communication with nurses, responsiveness of hospital staff, pain management, communication about medicines, discharge information) and two individual measures (cleanliness of the hospital environment and quietness of the hospital environment) (Appendix SA2). Publicly reported scores are patient case mix adjusted (Centers for Medicare and Medicaid Services; Elliott et al. 2009). Because the study used deidentified data that were previously collected for other purposes, the study was deemed exempt by the Harvard Medical School Committee on Human Studies.

Study Cohort

We selected women with a first diagnosis of breast cancer during 1992–2007 who were ≥ 66 years old and enrolled in Parts A and B of fee-for-service Medicare as of 1 year before their breast cancer diagnosis ($N = 51,878$). We excluded 614 women whose diagnosis was reported only by autopsy or death certificate, 378 with bilateral cancers, and 982 patients with histologies suggesting a cancer other than primary breast cancer. We restricted the cohort to the 40,857 women with stage I–III breast cancer and then excluded 3,980 women who disenrolled from Part A or B of Medicare, joined a health maintenance organization or died within 9 months of diagnosis, or who had no claims during the period from 45 days before diagnosis through 195 days after diagnosis (because of concern for an inaccurate match).

Because our focus was on choice of hospital for breast cancer surgery, we excluded 1,643 women who did not undergo primary surgery for their stage I, II, or III cancer, 1,563 with a physician but no hospital claim for surgery, 124 whose hospital could not be identified, and 73 women with missing census tract. We limited our cohort to the 32,630 non-Hispanic white and non-Hispanic black women in Detroit and Atlanta; non-Hispanic white, non-Hispanic Black, Asian, and Hispanic women in Los Angeles; and Asian, non-Hispanic white, and non-Hispanic black women in San Francisco (excluding 865 women across the four regions). Finally, we excluded 1,808 women who underwent surgery at hospitals located outside of SEER areas (because we could not reliably ascertain hospital characteristics and because they were not choosing from the same set of area hospitals), 76 women who traveled >50 miles for surgery and 304 women in a geographically isolated section of northern Los Angeles County (because these groups were not considering the same set of hospitals as other women in the areas), and 1,386 patients who had surgery at hospitals performing fewer than 40 breast-conserving surgeries because we could not characterize breast cancer quality at these low-volume hospitals. The final cohorts included 10,746 women in Detroit, 4,018 women in Atlanta, 9,433 women in Los Angeles, and 4,856 women in San Francisco.

Variables of Interest

Outcome variable: Choice of hospital for breast cancer surgery. We identified the hospital where each patient underwent her most definitive breast cancer surgery (mastectomy or breast-conserving surgery) within 6 months of diagnosis.

Independent Variables. Distance to hospitals. We obtained the latitude and longitude of the centroid of the census tract of residence for each patient and the location of each hospital in her SEER area using ArcGIS[®] geographic information mapping software version 9.3 by ESRI, CA. We calculated distance based on the shortest driving path between the two points.

Patient race/ethnicity. We classified women as non-Hispanic white, non-Hispanic black, Hispanic or Asian, based on SEER's medical record abstraction, with Hispanic ethnicity information supplemented by the Hispanic Identification Algorithm from the North American Association of Central Cancer Registries (NACCR 2003, 2005).

Hospital characteristics. We characterized *hospital racial composition* for each hospital based on discharges for all Medicare patients with all diagnoses in the 5 percent Medicare inpatient data. As a marker of safety-net status, we calculated the *proportion of patients whose care was covered by Medicaid* (Werner, Goldman, and Dudley 2008) by dividing total Medicaid inpatient discharges by total hospital admissions for each year obtained from the Medicare Hospital Cost Reports. We defined *breast cancer surgical volume* as the number of patients with stage I/II breast cancer who underwent mastectomy or breast-conserving surgery at that hospital during the study period. We used data from Medicare cost reports to characterize each hospital's *teaching status* if the hospital reported having a residency program and whether the hospital had *onsite radiation* available (Schrug et al. 2002).

Hospital Quality. We characterized *hospital quality* using two measures. First, we calculated the proportion of women receiving breast-conserving surgery for early-stage breast cancer at each hospital who were also treated with radiation (Keating et al. 2009). To avoid differences in quality explained entirely by the case mix of patients treated at a given hospital (e.g., if older women are less likely to get radiation and one hospital has more older women), we adjusted this measure to account for differences in patient characteristics, including race/ethnicity, age, marital status, year of diagnosis, urban residence, prior nonbreast cancer, tumor grade, tumor size, histology, and estrogen/progestin receptor status. Second, we created a mean HCAHPS score of patient experiences by calculating the proportion of patients at each hospital who reported the most favorable category (or "top box") for each of the six composite measures and the two

stand-alone items (e.g., a response of “always” or “yes”) (Elliott et al. 2009; Iannuzzi et al. 2015) (Appendix SA2).

Analyses

Our modeling strategy assumes that each patient has a probability of going to each of the hospitals in the choice set (defined as the SEER area). We modeled the sorting of patients to hospitals due to location (i.e., the inverse relationship of probability of choosing a hospital with the distance between the hospital and the patient’s residential address) and then to identify selection driven by factors other than distance alone. We fitted multinomial-logit discrete choice models (McFadden 1974; Ang 2007) to assess the probability that each patient goes to each hospital within the choice set of hospitals in the area. The model is of the form

$$P_{ih} = \frac{\exp \left[-f(d_{ih}, \lambda) + \gamma_h + \sum_{q=1}^Q \beta_q X_{iq} Z_{hq} \right]}{\sum_{h' \in H_i} \exp \left[-f(d_{ih'}, \lambda) + \gamma_{h'} + \sum_{q=1}^Q \beta_q X_{iq} Z_{h'q} \right]}$$

where $P_{i,h}$ denotes the probability that patient i goes to hospital h within her choice set H_i , d_{ih} is residence-to-hospital distance, f is a linear spline function with knots at 5 and 15 miles and coefficients λ , γ_h is a hospital-specific intercept (hospital fixed effect) that accommodates overall volume for each hospital, and the final summation interacts patient characteristics X_{iq} with hospital characteristics Z_{hq} . This model specifies that the probability of choice is related to distance, the hospital’s overall share of the patients, and the interaction between some specific hospital and patient attributes of interest ($X_{iq}Z_{hq}$). A simplified model that includes only the distance function and the hospital-specific intercept γ_h (but no other interactions) assumes that distance alone determines the patients’ choice of hospitals. To understand this model, note that the main effects of patient characteristics have no effect on predictions for each hospital, because the same term for patient characteristics (X_{iq}) appears in both the numerator and denominator, and thus cancels out. Thus, without knowing anything about a hospital, patients’ characteristics will not predict which hospitals they chose. Furthermore, the main effects of hospital characteristics have the same effect on the prediction for every patient; these effects are absorbed in the γ_h term for each hospital where the total number of patients predicted to choose that hospital is equal to that observed under maximum likelihood estimation. Therefore, the only effects relevant to predicting hospital choice for individual patients (or subgroups) are those that are

interactions of patient characteristics with hospital effects. These terms tell us which hospital characteristics in combination with which patient characteristics make it more or less likely that a patient will choose a certain hospital. In these interacted models, race/ethnicity is the patient characteristic of primary interest, coded as one (in Detroit and Atlanta) or more (in Los Angeles and San Francisco/San Jose) dummy variables, each for a specific minority race/ethnicity. In separate models, we included a term for the interaction of patient race/ethnicity with hospital characteristics Z_{hq} , including hospital racial composition, proportion of Medicaid discharges, breast cancer surgical volume, teaching status, and availability of radiation onsite. A positive estimate of coefficient β_q suggests that patients of the corresponding group are more likely than white cancer patients to go to a hospital with the corresponding characteristic, after adjustment for distance. We present odds ratios and 95 percent confidence intervals for these association coefficients.

Next, in each area, we calculated the adjusted rate of radiation after breast-conserving surgery and HCAHPS score at the hospitals where patients underwent surgery. We presented these rates for all women and for each racial/ethnic subgroup, and we calculated the observed difference for each racial/ethnic subgroup versus whites. We also calculated a predicted rate for each racial/ethnic subgroup based on a model that accounts only for distance, and we presented the predicted difference for each racial/ethnic subgroup versus whites, accounting for distance. Finally, we calculated the difference between the observed intergroup difference (white minus minority subgroup) and the difference predicted if the only factor affecting hospital choice were distance; this quantity estimates the residual intergroup difference due to selection of hospitals for their characteristics. An observed difference that differs significantly from the difference predicted by distance alone (with a difference-in-difference that is negative with a confidence interval not including zero) suggests that factors other than location are driving patients' choice of hospital in a manner that may disadvantage particular groups. For all differences, we used bootstrap methods to calculate 95 percent confidence intervals. Analyses were conducted using *SAS* statistical software, version 9.2 (Cary, NC).

As described above, our discrete choice models focused on a single patient characteristic (race/ethnicity) and its influence on hospital choice. Other patient characteristics (e.g., age, tumor characteristics) might also lead patients differentially to higher or lower quality hospitals. Therefore, in sensitivity analyses, we interacted all patient characteristics (race/ethnicity, age, marital status, year of diagnosis, urban residence, prior nonbreast cancer,

tumor grade, tumor size, histology, and estrogen/progestin receptor status) with a hospital quality characteristics (fitting two sets of models, one for the radiation after breast-conserving surgery measure, the other for the HCAHPS measures). Results were similar and are not presented. In addition, because HCAHPS data were not available until 2007, we conducted a sensitivity analysis restricting to patients diagnosed in 2000 or later. Finally, we sought to better understand care for women who were excluded based on traveling to hospitals outside of their SEER area or more than 50 miles and who went to very small hospitals. We could not assess rates of radiation after breast-conserving surgery for these hospitals, but compared HCAHPS scores at included hospitals versus excluded hospitals using *t*-tests when HCAHPS scores were nonmissing.

RESULTS

Characteristics of the patients and hospitals appear in Table 1. In Detroit, 10,746 patients (15.6 percent black) were treated in 31 hospitals. In Atlanta, 4,018 patients (16.3 percent black) were treated at 15 hospitals. In San Francisco, 4,856 patients (6.3 percent black and 7.0 percent Asian) were treated at 27 hospitals. In Los Angeles, 9,433 patients (6.6 percent black, 4.8 percent Asian, and 9.1 percent Hispanic) were treated at 49 hospitals (Table 1).

In adjusted analyses, distance was significantly and negatively associated with probability of hospital choice in all four study areas (Table 2). After accounting for distance and other hospital characteristics, hospital racial composition (based on all Medicare discharges) was also associated with choice of hospital. Black breast cancer patients were more likely to go to a hospital that had a higher all-diagnosis proportion of black patients in Detroit (adjusted odds ratio [AOR] for a 10 percent increase in the proportion of black patients = 1.25, 95 percent CI = 1.21–1.30), Atlanta (AOR = 1.54, 95 percent CI = 1.43–1.66), San Francisco (AOR = 1.36, 95 percent CI = 1.11–1.68), and Los Angeles (AOR = 1.36, 95 percent CI = 1.26–1.46). Asians breast cancer patients were more likely to go to hospitals with a higher proportion of Asian patients in San Francisco (AOR = 1.96, 95 percent CI = 1.75–2.63) and in Los Angeles (AOR = 1.82, 95 percent CI = 1.65–2.02). In Los Angeles, Hispanic breast cancer patients were more likely to go to a hospital with a higher proportion of Hispanic patients (AOR = 1.57, 95 percent CI = 1.31–1.88).

Table 1: Characteristics of the Patients and Hospitals by SEER Area

	Detroit	Atlanta	San Francisco	Los Angeles
Number of patients	10,746	4,018	4,856	9,433
Patient race/ethnicity, <i>N</i> (%)				
White	9,070 (84.4%)	3,365 (83.7%)	4,212 (86.7%)	7,498 (79.5%)
Black	1,676 (15.6%)	653 (16.3%)	305 (6.3%)	618 (6.6%)
Asian	—	—	339 (7.0%)	455 (4.8%)
Hispanic	—	—	—	862 (9.1%)
Mean patient age (SD)	75.6 (6.4)	75.5 (6.5)	76.8 (6.8)	76.1 (6.7)
Married, <i>N</i> (%)	4,174 (38.8%)	1,590 (39.6%)	1,928 (39.7%)	4,047 (42.9%)
Stage at diagnosis, <i>N</i> (%)				
Stage 1	6,124 (57.0%)	2,337 (58.2%)	2,830 (58.3%)	5,299 (56.2%)
Stage 2	3,908 (36.4%)	1,406 (35.0%)	1,741 (35.8%)	3,538 (37.5%)
Stage 3	714 (6.6%)	275 (6.8%)	285 (5.9%)	596 (6.3%)
Number of hospitals	31	15	27	49
Median (range) proportion of minority patients across hospitals				
Blacks	11.5 (1.0–86.6)	21.2 (2.3–92.1)	5.4 (0–39.6)	4.5 (0.1–73.9)
Asians	—	—	3.9 (0.3–74.7)	3.7 (0.6–49.8)
Hispanics	—	—	—	3.1 (0.2–30.7)
Median (range) number of breast cancer surgeries	19.0 (4.9–89.8)	10.9 (3.5–36.4)	11.8 (3.9–31.2)	8.8 (2.9–63.7)
Teaching hospitals, <i>N</i> (%)	24 (77.4%)	<11 [†]	<11 [†]	28 (57.1%)
Radiation onsite, <i>N</i> (%)	<11 [†]	<11 [†]	<11 [†]	12 (24.5%)
% Discharges who are Medicaid patients, Median (range)	7.4 (1.5–21.7)	13.9 (1.8–48.6)	9.5 (0–62.5)	14.7 (0–76.1)
High-quality hospitals				
Median proportion of patients who undergo radiation after BCS (IQ range)	78.0 (70.6–81.4)	77.6 (66.5–85.9)	80.9 (73.3–83.6)	77.1 (71.4–86.7)
<i>N</i> hospitals with HCAHPS scores*	22	14	24	37
Median HCAHPS score (IQ range)	63.2 (60.1–66.6)	67.8 (66.0–71.9)	62.9 (61.2–69.6)	63.1 (59.3–65.5)

*HCAHPS scores were available for a subset of hospitals.

[†]Numbers <11 are suppressed for confidentiality.

BCS, breast-conserving surgery; HCAHPS, Hospital Consumer Assessment of Health Care Providers and Systems; SD, standard deviation; SEER, Surveillance, Epidemiology, and End Results.

Table 2: Factors Associated with Hospital Choice, Adjusted*

	Detroit		Atlanta		San Francisco		Los Angeles	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Effect of increasing distance for each mile if distance is								
<5 miles	0.84 (0.82–0.87)	<.001	0.74 (0.71–0.79)	<.001	0.69 (0.68–0.72)	<.001	0.68 (0.66–0.69)	<.001
5–15 miles	0.82 (0.81–0.83)	<.001	0.78 (0.78–0.80)	<.001	0.71 (0.70–0.73)	<.001	0.74 (0.72–0.74)	<.001
>15 miles	0.85 (0.85–0.86)	<.001	0.84 (0.83–0.85)	<.001	0.84 (0.83–0.85)	<.001	0.86 (0.85–0.87)	<.001
Hospital racial composition								
10% increase in the proportion of blacks in hospital								
Blacks	1.25 (1.21–1.30)	<.001	1.54 (1.43–1.66)	<.001	1.36 (1.11–1.68)	0.004	1.36 (1.26–1.46)	<.001
Asians	–	–	–	–	0.77 (0.68–0.97)	0.02	1.29 (1.12–1.49)	<.001
Hispanics	–	–	–	–	–	–	1.0 (0.75–1.32)	0.97
10% increase in the proportion of Asians in hospital								
Blacks	–	–	–	–	0.89 (0.65–1.23)	0.5	0.79 (0.67–0.93)	0.004
Asians	–	–	–	–	1.96 (1.75–2.63)	<.001	1.82 (1.65–2.02)	<.001
Hispanics	–	–	–	–	–	–	0.86 (0.64–1.16)	0.32
10% increase in the proportion of Hispanics in hospital								
Blacks	–	–	–	–	–	–	1.05 (0.98–1.13)	0.16
Asians	–	–	–	–	–	–	1.10 (1.0–1.2)	0.05
Hispanics	–	–	–	–	–	–	1.57 (1.31–1.88)	<.001
10% Medicaid increase	1.50 (1.27–1.76)	<.001	1.06 (0.96–1.17)	0.26	1.48 (1.10–2.0)	0.009	1.27 (1.15–1.41)	<.001
for blacks								
10% Medicaid increase	–	–	–	–	0.95 (0.76–1.19)	0.68	1.30 (1.16–1.45)	<.001
for Asians								
10% Medicaid increase	–	–	–	–	–	–	1.25 (1.16–1.35)	<.001
for Hispanics								
10% volume increase	0.84 (0.82–0.86)	<.001	1.19 (1.02–1.39)	0.02	1.20 (0.91–1.59)	0.2	1.02 (0.95–1.09)	0.62
for blacks								

Continued

Table 2. Continued

	Detroit		Atlanta		San Francisco		Los Angeles	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
10% volume increase for Asians	—	—	—	—	1.36 (1.06–1.75)	0.02	1.00 (0.92–1.09)	0.26
10% volume increase for Hispanics	—	—	—	—	—	—	0.96 (0.90–1.03)	0.96
Teaching hospital for blacks	0.84 (0.67–1.06)	0.139	0.97 (0.76–1.25)	0.82	0.94 (0.53–1.65)	0.83	1.34 (1.06–1.69)	0.01
Teaching hospital for Asians	—	—	—	—	1.03 (0.67–1.59)	0.88	2.63 (2.0–3.46)	<.001
Teaching hospital for Hispanics	—	—	—	—	—	—	0.72 (0.57–0.91)	0.02
Radiation onsite for blacks	0.85 (.68–1.07)	0.18	0.45 (0.25–0.81)	0.007	0.64 (0.37–1.1)	0.1	0.87 (0.60–1.28)	0.48
Radiation onsite for Asians	—	—	—	—	0.45 (0.27–0.74)	0.001	1.04 (0.72–1.51)	0.82
Radiation onsite for Hispanics	—	—	—	—	—	—	0.72 (0.57–0.91)	0.006

Notes: Bold values are statistically significant at $p < .05$.
*Adjusted for all variables in the table.
CI, confidence interval; OR, odds ratio.

Choice of hospital was also associated with the proportion of Medicaid discharges (a marker of hospital safety-net status) for minority patients in most areas. Black breast cancer patients were more likely to go to a hospital with a higher proportion of Medicaid patients in Detroit (AOR for each 10 percent increase in the proportion of Medicaid patients = 1.50, 95 percent CI = 1.27–1.76), San Francisco (AOR = 1.48, 95 percent CI = 1.10–2.0), and Los Angeles (AOR = 1.27, 95 percent CI = 1.15–1.41). In Los Angeles, Asian breast cancer patients and Hispanic breast cancer patients were also more likely to go to a hospital with a higher proportion of Medicaid patients (AOR for Asians = 1.30, 95 percent CI = 1.16–1.45; AOR for Hispanics = 1.25, 95 percent CI = 1.16–1.35).

Black breast cancer patients were less likely to go to higher volume hospitals in Detroit (AOR for each 10 percent increase in breast cancer surgical volume = 0.84, 95 percent CI = 0.82–0.86) and more likely to go to higher volume hospitals in Atlanta (AOR = 1.19, 95 percent CI = 1.02–1.39). Asian breast cancer patients were more likely to go to higher volume hospitals in San Francisco (AOR = 1.36, 95 percent CI = 1.06–1.75).

In Los Angeles, black and Asian breast cancer patients were more likely than white patients to go to a teaching hospital; there was no association between race and teaching hospital status in other areas. Black patients in Atlanta, Asian patients in San Francisco, and Hispanic patients in Los Angeles were less likely to go to a hospital with radiation treatment onsite.

Table 3 and Figure 1, Panel A present differences in adjusted rates of radiation after breast-conserving surgery at the hospitals where women were treated overall and by race/ethnicity. Black patients in Detroit and black and Asian patients in San Francisco and Los Angeles had care at hospitals with lower scores than whites for this indicator. For blacks in each of these areas, but not Asians, a substantial portion of this difference was not explained by living nearer to lower quality hospitals (Figure 1). In Atlanta, black women were treated at hospitals with higher rates of radiation after breast-conserving surgery than white women, although this difference was entirely explained by living nearer to such hospitals (Figure 1). Hispanics in Los Angeles did not differ significantly from whites in hospital rates of radiation after breast-conserving surgery.

Table 3 and Figure 1, Panel B present findings for the HCAHPS scores. Black patients in Atlanta and blacks and Asians in San Francisco and Los Angeles went to hospitals with lower HCAHPS scores than whites, although the magnitude of the differences in Los Angeles was small. Most of these differences were not explained by living nearer to lower quality hospitals, except

Table 3: Observed Rates of Surgery at a High-Quality Hospital Based on Race/Ethnicity and Predicted Rates If Choice of Hospital Was Based Only on Distance

	<i>Adjusted Rate and Differences in Radiation after Breast-Conserving Surgery at Hospitals Where Patients Treated</i>	<i>Score and Differences in Patients' Experiences from HCAHPS at Hospitals Where Patients Treated</i>
Detroit		
Rate of indicator across hospitals for . . .		
All patients	81.6	63.6
White patients	82.1	63.5
Black patients	78.8	64.1
Black–white difference		
Observed difference	−3.3 (−3.5 to −3.1)*	0.6 (0.4 to 0.7)*
Predicted difference if account for distance	−0.9 (−1.0 to −0.8)*	0.6 (0.6 to 0.7)*
Difference not explained by distance	−2.4 (−2.5 to −2.2)*	−0.1 (−.2 to 0.1)
Atlanta		
Rate of indicator across hospitals for . . .		
All patients	80.1	68.8
White patients	79.7	69.4
Black patients	82.0	65.4
Black–white difference		
Observed difference	2.3 (1.7 to 2.9)*	−4.0 (−4.3 to −3.7)*
Predicted difference if account for distance	2.2 (1.9 to 2.6)*	−1.5 (−1.6 to −1.3)*
Difference not explained by distance	0.04 (−.4 to .5)	−2.6 (−2.8 to −2.3)*
San Francisco		
Rate of indicator across hospitals for . . .		
All patients	79.3	64.9
White patients	79.6	65.3
Black patients	77.0	62.7
Asian patients	78.7	61.5
Black–white difference		
Observed difference	−2.5 (−3.4 to −1.6)*	−2.7 (−3.1 to −2.2)*
Predicted difference if account for distance	−1.4 (−1.9 to −0.8)*	−2.6 (−2.8 to −2.3)*
Difference not explained by distance	−1.1 (−1.9 to −0.4)*	−0.1 (−0.5 to 0.3)
Asian–white difference		
Observed difference	−0.9 (−1.5 to −0.2)*	−3.9 (−4.4 to −3.4)*
Predicted difference if account for distance	−0.8 (−1.2 to −0.4)*	−1.0 (−1.2 to −0.7)*
Difference not explained by distance	−0.1 (−0.6 to 0.4)	−2.9 (−3.4 to −2.4)*
Los Angeles		
Rate of indicator across hospitals for . . .		
All patients	80.7	63.1
White patients	81.1	63.2
Black patients	77.7	62.7
Hispanic patients	80.9	62.9
Asian patients	78.2	62.6

Continued

Table 3. Continued

	<i>Adjusted Rate and Differences in Radiation after Breast-Conserving Surgery at Hospitals Where Patients Treated</i>	<i>Score and Differences in Patients' Experiences from HCAHPS at Hospitals Where Patients Treated</i>
Black–white difference		
Observed difference	−3.3 (−4.0 to −2.6)*	−0.4 (−0.8 to −0.1)*
Predicted difference if account for distance	−2.1 (−2.4 to −1.9)*	−0.1 (−0.2 to 0.1)
Difference not explained by distance	−1.2 (−1.8 to −0.6)*	−0.4 (−0.5 to −0.1)*
Asian–white difference		
Observed difference	−2.9 (−3.6 to −2.1)*	−0.5 (−1.0 to −0.1)*
Predicted difference if account for distance	−1.3 (−1.7 to −1.0)*	−0.0 (−0.2 to 0.2)
Difference not explained by distance	−0.9 (−3.9 to 2.0)	−0.5 (−0.9 to −0.1)*
Hispanic–white difference		
Observed difference	−0.1 (−0.6 to 0.4)	−0.2 (−0.6 to 0.1)
Predicted difference if account for distance	−0.3 (−0.6 to −0.01)*	0.1 (−0.02 to 0.3)
Difference not explained by distance	0.2 (−0.3 to 0.6)	−0.4 (−0.7 to −0.03)*

Note. Bold values are statistically significant at $p < .05$.

the difference for blacks versus whites in San Francisco (Figure 1). Black patients in Detroit were treated at higher quality hospitals than whites for this measure, a difference that was fully explained by living nearer to higher quality hospitals.

In sensitivity analyses restricted to patients diagnosed in 2000 or later, results were generally similar (Appendix SA2), with a few differences. Specifically, in the analyses examining factors associated with hospital choice

Figure 1: Summary of Findings for Racial/Ethnic Differences in Quality Measures and the Source of Differences. The figure depicts differences, in percentage points, for each comparison (minority group minus white) as well as the share of the portion explained by location (shaded portion of each bar) and by hospital–patient interactions other than location (dotted portion of each bar). (A) shows results for the radiation after breast-conserving surgery measure; (B) shows results for the HCAHPS measure. *Reflects a statistically significant overall difference for the relevant racial/ethnic group relative to whites. †Reflects a portion of the difference explained by location that is significantly different from 0. ‡Reflects a portion of the difference explained by hospital–patient interactions that is significantly different from 0. Negative values indicate differences unfavorable to the minority group relative to whites.

A. Radiation after Breast-Conserving Surgery

B. HCAHPS Scores

(Table 2), Asian women in San Francisco were no longer more likely than whites to go to a higher volume hospital, and Asians and Hispanics in Los Angeles were less likely than whites to go to a higher volume hospital (Table S1). Also, from 2000 on, black patients in Detroit and Atlanta were more likely to go to a hospital with onsite radiation therapy, while Asians in Los Angeles were less likely to choose hospitals with onsite radiation. In the analyses examining observed rates of surgery at a high-quality hospital based on race/ethnicity and predicted rates if the choice of hospital was based only on distance, results were similar to our main analyses except for choice of hospital for blacks and whites, where blacks were no longer less likely than white patients to have care at hospitals with lower rates of radiation after breast-conserving surgery (Table S2). When we compared HCAHPS scores at the 156 of 249 hospitals out of SEER areas for which we had HCAHPS scores, we found no difference in mean scores (63.7 vs. 64.9, $p = .10$). Mean HCAHPS scores were slightly lower for the 72 of 134 excluded small hospitals with HCAHPS scores versus included hospitals (61.1 vs. 63.7, $p = .02$).

DISCUSSION

We modeled choice of hospital for breast cancer surgery among a large cohort of women in four metropolitan areas with racial/ethnic diversity. In each area, proximity was an important predictor of hospital choice. However, factors other than distance were differentially predictive of choice of hospital for minority versus white patients, including the racial composition of other patients in the hospital (in all areas) and the proportion of Medicaid patients treated at the hospital (in all areas except Atlanta). In three of the four areas studied (Detroit, San Francisco, and Los Angeles), black patients were less likely to receive care at hospitals with high rates of radiation following breast-conserving surgery, and the differences were not explained by location. We found similar associations for Asian, but not Hispanic women, in Los Angeles, although the differences were partly explained by distance and smaller differences that were explained by distance for Asians in San Francisco. Differences in the HCAHPS scores were lower for black women in all areas except Detroit and for Asian women, although some differences were small; most were not explained by distance.

A growing literature suggests that care for minority patients is concentrated in subsets of hospitals that tend to be located in urban areas and are often of lower quality (Barnato et al. 2005; Skinner et al. 2005; Liu et al.

2006; Lucas et al. 2006; Hasnain-Wynia et al. 2007; Jha et al. 2007). More recent data suggest that these differences are not explained by proximity (Sarrazin, Campbell, and Rosenthal 2009; Dimick et al. 2013). Despite living nearer to higher quality hospitals, black patients are more likely than white patients to undergo major surgical procedures at lower quality hospitals, particularly in areas with high levels of racial segregation (Dimick et al. 2013). Our findings support and extend this prior work. The racial/ethnic segregation we observed despite adjustment for location underscores that the concentration of minority group patients in certain hospitals represents more than the effect of geography. To some extent the association of choice of a hospital with the racial/ethnic composition of its other patients may reflect patient preferences to have care at a hospital used by others with similar backgrounds. As well as allowing patients to interact and share hospital rooms with patients who are more similar to them, these institutions may also be more adapted to providing culturally and linguistically concordant services and environments. This observation is consistent with previous studies showing that non-white patients more often seek care from physicians of their own race (Saha et al., 1999) and report greater satisfaction with care received from race-concordant physicians (Saha et al., 1999; Laveist and Nuru-Jeter, 2002) and language-concordant physicians (Gonzales, Vega, and Tarraf, 2010). Although we did not have data on the racial/ethnic composition of the physicians and nurses at the hospitals where large numbers of minority patients obtained care, it is likely that minority staff were better represented at these hospitals than at hospitals primarily serving white patients.

Nonetheless, it is important to recognize that “choice” in the neutral sense in which we use the term does not necessarily reflect preferences; choices may be narrowly channeled by institutional and resource constraints. Indeed, concentration of minority patients in a few hospitals could be explained entirely by such factors in the absence of any patient preferences for culturally concordant settings. Thus, our findings may also be explained in part by physician referral patterns. Previous research has shown that minority patients compared with white patients receive a disproportionate fraction of their care from physicians who are less well trained (Bach et al. 2004). These physicians may be more often affiliated with certain lower quality hospitals. Furthermore, well-resourced high-quality hospitals may choose to build primary care networks in areas with higher income commercially insured populations, leaving publicly insured patients for whom reimbursement rates are lower to be served by physicians affiliated with safety-net institutions. In either case, physicians are likely to direct patients to specialists at these hospitals.

Other access issues might also play a role in concentrating minority breast cancer patients. More research is needed to understand the extent to which choice of hospital for cancer surgery is driven by patient preferences, preferences of their physicians, or institutional arrangements. In the meantime, interventions to improve care at lower quality hospitals, which could involve increasing resources, may help to decrease disparities in breast cancer care. Alternatively, improving cultural and language competency among providers at hospitals caring for fewer minority patients may help direct patients to these hospitals, which are often better performing, as may supporting physicians in referring patients to higher performing hospitals. More widespread public indicators of quality or incentives to physicians or patients may help in this regard.

A strength of our study is that we examined two different measures of quality for patients of black, Hispanic, and Asian race/ethnicity across four metropolitan areas. An important finding of our work is that there was not one clear pattern for our findings across areas and racial/ethnic groups. This finding underscores the need to examine care patterns in more than one area or racial/ethnic group.

Our findings should be interpreted in light of several limitations. First, we studied older women with breast cancer residing in Detroit, Atlanta, Los Angeles, and San Francisco; thus, the generalizability of our findings to other patients in different parts of the country requires further study. However, older women make the majority of breast cancer patients and the racial/ethnic diversity of the population in these four metropolitan areas coupled with the relatively high concentration of hospitals is representative of urban areas in the United States. Second, our hospital quality measures were limited, and one of our measures was based on rates of radiation following breast-conserving surgery. Research suggests that adjuvant radiation may be safely omitted for select women aged 70 years and older (Hughes, et al., 2013), suggesting that lower rates of radiation might not signal low-quality care if the decision is made appropriately. However, when we redefined high-quality hospitals using HCAHPS patient scores, we found generally similar associations. The HCAHPS measure was limited in that HCAHPS data were from 2007, the first year that such data were reported and overlapping only the very end of our study period. We expect that patients' experiences remain relatively stable over time, and results for analyses using the HCAHPS data were similar when we restricted the cohort to patients diagnosed in 2000 or later. Third, our distance calculations were based on the distance from the patients' census tract centroid to each hospi-

tal using the shortest driving path between the two points. We did not have information on whether the patients used public transportation to access the hospitals and did not consider travel time. However, as we focused on urban areas, it is unlikely that accessing hospitals via public transportation would significantly alter our distance calculations, and previous data suggest a high correlation between travel time and distance (Phibbs and Luft, 1995). Fourth, we had no information on individual patients' socioeconomic and insurance status, including dual eligibility for Medicaid and Medicare. Even though all of our patients had Medicare, which fully covers primary breast cancer surgery, our finding that minority patients were more likely to receive care at hospitals with a higher proportion of Medicaid patients (except in Atlanta) could be explained by patterns of care established prior to Medicare eligibility if patients were previously on Medicaid or uninsured, or could be because patients are dually covered by Medicare and Medicaid. Finally, the differences we observed were modest overall, but similar to those reported in other studies (Skinner et al. 2005) and could still have important implications given the large number of women treated for breast cancer in the United States each year.

In conclusion, we found that among minority breast cancer patients in urban metropolitan areas, proximity only partially explained the location of the hospital they chose for breast cancer surgery. Black, Asian, and Hispanic patients were more likely than white patients to have surgery at hospitals with a higher proportion of other patients of similar race/ethnicity. In some areas, for black and Asian but not Hispanic patients, these were often of lower quality. More research is needed to understand how patients choose the hospitals and physicians from whom they obtain care. In addition, efforts to improve care at lower quality hospitals caring for large numbers of minority patients, efforts to improve cultural competence among physicians potentially caring for minority patients, and ameliorating barriers to referral and access to higher quality institutions may help to decrease racial and ethnic disparities in care. Such policies should consider referral patterns and other issues affecting patients' access to high-quality care.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: This study used the linked SEER-Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors. The authors acknowledge the efforts of the

Applied Research Program, NCI; the Office of Research, Development and Information, CMS; Information Management Services (IMS), Inc.; and the Surveillance, Epidemiology, and End Results (SEER) Program tumor registries in the creation of the SEER-Medicare database. The collection of the California cancer incidence data used in this study was supported by the California Department of Public Health as part of the statewide cancer reporting program mandated by California Health and Safety Code Section 103885; the National Cancer Institute's Surveillance, Epidemiology and End Results Program under contract N01-PC-35136 awarded to the Northern California Cancer Center, contract N01-PC-35139 awarded to the University of Southern California, and contract N02-PC-15105 awarded to the Public Health Institute; and the Centers for Disease Control and Prevention's National Program of Cancer Registries, under agreement #U55/CCR921930-02 awarded to the Public Health Institute. The ideas and opinions expressed herein are those of the author(s) and endorsement by 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 is not intended nor should be inferred. This paper was developed while Yulei He was at Harvard Medical School. The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the National Center for Health Statistics, Centers for Disease Control and Prevention. The study was supported by Susan G. Komen for the Cure.

Disclosures: None.

Disclaimers: None.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2. Hospital Quality Based on HCAHPS Survey.

Table S1. Factors Associated with Hospital Choice in Sensitivity Analysis Restricting to Patients Diagnosed in 2000 or Later.

Table S2. Sensitivity Analysis for Observed Rates of Surgery at a High-Quality Hospital Based on Race/Ethnicity and Predicted Rates If Choice of Hospital Was Based Only on Distance after Restricting to Individuals Diagnosed in 2000 or Later.