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Catherine Osborn Date

An investigation of the association between racial disparities in breast cancer treatment outcomes and facility characteristics

By

Catherine Osborn
Master of Public Health

Epidemiology

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By

Catherine Osborn

B.S., University of Georgia, 2016

Thesis Committee Chair: Lauren E. McCullough, PhD, MSPH

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Abstract

An investigation of the association between racial disparities in breast cancer treatment outcomes and facility characteristics
By Catherine Osborn

Previous epidemiologic studies have found that racial disparities in breast cancer-specific mortality are partially attributed to increased surgical delays for black women compared to white women, even after controlling for insurance coverage and access to care. Previous studies have also found that racial disparities in breast cancer outcomes may be partially attributed to the facility in which women receive treatment. No previous studies have investigated whether the racial disparities in treatment delays and mortality are associated with facility-level characteristics. The current study investigates which facility characteristics are associated with increased racial disparities in surgical delays for breast cancer treatment and in breast cancer-specific mortality. Logistic regression was used to model facility characteristics and treatment delay. Cox proportional hazard regression was used to model facility characteristics and mortality. Interactions by patient race was assessed for both associations. The final sample included 3,857 white and 2,341 black women from 35 Metro Atlanta surgical facilities. The median surgical delay was higher in black women (36.0; SD=50.69) compared to white women (29.0; SD=26.50). The largest disparities in delay between white and black women were among patients with Medicare, patients treated in low or moderate volume facilities, government facilities, or facilities with an ACOSOG affiliation. Facilities without a medical school affiliation had lower odds of surgical delay for white patients (aOR=0.89, 95% CI: 0.71, 1.11), but higher odds among black patients (aOR=1.11, 95% CI: 0.92, 1.34). Government (aOR=0.72, 95% CI: 0.66, 0.79) and for-profit hospitals (aOR=0.72, 95% CI: 0.81, 0.89) had lower odds of surgical delay compared to non-profit hospitals. High facility volume was inversely associated with mortality among white patients (aHR=0.60, 95% CI: 0.44, 0.83), yet positively associated among black patients (aHR=1.32, 95% CI: 0.85, 2.05). COC-accreditation was inversely associated with mortality among white patients (aHR=0.69, 95% CI: 0.38, 1.17), yet positively associated among black patients (aHR=1.18, 95% CI: 0.74, 1.88). Future studies with larger samples of patients, which can obtain surgical delay and breast cancer-specific mortality should continue to investigate the associations between various facility characteristics and patient outcomes.

An investigation of the association between racial disparities in breast cancer treatment outcomes and facility characteristics

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CHAPTER I: BACKGROUND/LITERATURE REVIEW

1.1 Breast Cancer Epidemiology and Treatment

1.1.1 Epidemiology and risk factors

With an estimated 266,120 new cases in 2018, breast cancer is the most frequently diagnosed cancer in US women, besides non-melanoma skin cancer.[1] Additionally, second only to lung cancer, invasive breast cancer is the leading cause of cancer-related mortality in US women, killing an estimated 40,920 women in 2018. While those numbers are concerning, they have been continuously improving over the past few decades due to advancements in early detection and treatment methods. For instance, breast cancer mortality rates have decreased by approximately 38% between 1989 and 2014.

Previous studies have identified several non-modifiable risk factors and potentially modifiable risk factors for developing breast cancer. The two most significant non-modifiable risk factors are being biologically female and advanced age.[2,3] Other common non-modifiable risk factors include inherited gene mutations[4], a family or personal history of breast cancer[5], high breast tissue density[6], radiation exposure to the chest at a young age[7], and early menarche or late menopause.[8] Risk factors that can potentially be modified through behavior include post-menopausal hormone use[9], alcohol consumption[10], overweight/obesity[11], and nulliparity or first pregnancy at age 35 years or older.[12] Factors associated with decreased breast cancer risk include regular physical exercise and breastfeeding for at least one year.[13,14]

1.1.2 Breast cancer subtypes

There are several intrinsic breast cancer subtypes, each of which has distinct metastatic behavior and clinical implications.[15,16] Breast cancer subtypes can be approximated by their hormone receptor (HR) status and expression of the human epidermal growth factor receptor 2 (HER2) gene, The four main molecular subtypes are defined as luminal A (HR+/HER2-), luminal B (HR+/HER2+), HER2-enriched (HR-/HER2+), and triple negative breast cancer (TNBC) (HR-/HER2-). There is evidence that differences in subtype rates, along with demographic patterns and access to care, may account for some variations in breast cancer incidence and mortality across racial and ethnic groups.

Rates of luminal A breast cancer, the least aggressive subtype that typically has the best prognosis, are highest among whites. Furthermore, studies have shown that, among every racial/ethnic group, increased levels of poverty are associated with decreased rates of luminal A breast cancer.[17] Luminal B breast cancer tends to be more aggressive and may have a slightly worse prognosis compared to luminal A breast cancer. HER2-enriched breast cancers are usually more aggressive and have a worse prognosis compared to both luminal subtypes. However, HER2-enriched breast cancers can often be successfully treated with targeted therapies, such as trastuzumab. Rates of TNBC are higher in women with the *BRCA1* gene, as well as in younger and black women.[18] In addition to subtype, it is also important to note that black women are more likely to have poorly prognostic molecular features compared to other race and ethnic groups, which may have major negative clinical implications during treatment for the patient.[17]

1.1.3 Treatment of breast cancer

Breast cancer can be detected and diagnosed using procedures such as mammography, ultrasound, breast magnetic resonance imaging, and biopsy. Following a diagnosis, breast cancer patients may undergo various combinations of multiple treatment methods (surgery, radiation therapy, chemotherapy, and hormone therapy) depending on multiple factors, including the cancer stage and subtype.[19] The two main surgical treatment options include breast conserving surgery, which involves only removing the tumor and surrounding tissue, and total mastectomy, which involves removing the entire breast(s). In addition to surgery, radiation therapy, chemotherapy and hormone therapy employ various means to eliminate or inhibit further growth of cancerous cells. Patients may also choose to participate in clinical trials that test the efficacy of new drugs or combination treatment options.[19] Receipt of accurate diagnoses, definitive treatment plans, and timely treatments can have substantial implications for prognosis and survival among breast cancer patients.[20]

1.2 Racial Disparities in Breast Cancer

The improvements in breast cancer outcomes over the past few decades have not been equitable for all US women. Racial disparities in invasive breast cancer outcomes between white and black women have steadily increased. While black women have higher chances of dying from breast cancer, they have a lower incidence rate (123.2 per 100,000) compared to white women (133.8 per 100,000).[21] In the 1980s, invasive breast cancer mortality rates were almost equitable between white and black women. However, between 1980 and 2015, the age-adjusted mortality rates for breast cancer in white women decreased approximately three times faster than the corresponding mortality rates

in black women. Based on the most recent US breast cancer statistics between 2011 and 2015, the age-adjusted mortality rate is lower in white women (20.3 per 100,000 persons) compared to black women (28.7 per 100,000). Furthermore, the five-year relative survival among women of all ages diagnosed between 2008 and 2014 is nearly ten percent higher for whites (92.1%) compared to blacks (83.1%). These disparities are more pronounced among women under 40, with the mortality rate for black women being twice the mortality rate for white women.[22] It is important to note that the mortality disparity remains after adjustment for age, tumor characteristics, and lifestyle factors.[23]

Race disparities in mortality rates are, in part, because black women are more likely to be diagnosed at a more progressed breast cancer stage compared to white women.[22] However, even after for controlling for breast cancer stage, the adjusted hazard rate ratio for black women is 34% higher than that of white women,[24] and five-year survival disparities are most pronounced among women who are diagnosed with early stage disease. For example, the disparity in five-year survival for cancers diagnosed at a localized stage (99.1% for whites; 81.2% for blacks) is more extreme than the disparities for cancers diagnosed at a distant stage (28.1% for whites; 19.7% for blacks).[21] These data suggest that the survival disparities might be due to disparities in treatment actions taken during the early, critical stages of breast cancer.

1.3 Treatment Disparities

Several studies have provided evidence that the racial disparity in breast cancer outcomes is partially due to disparities in the receipt of breast cancer treatment. Compared to white women, black women are less likely to receive a definitive primary

treatment plan.[20] Black women are also less likely to receive breast cancer surgery as part of their treatment plan.[22] Additionally, black women are less likely to undergo sentinel lymph node biopsy, an innovative morbidity-sparing procedure, as a primary staging procedure compared to white women.[25]

Among the black patients that receive treatment, they are more likely to experience delays in breast cancer treatment compared to white women.[26-28] In one study, black breast cancer patients were nearly twice as likely to have their treatment delayed for more than six weeks after diagnosis (15.3%) compared to white breast cancer patients (8.1%).[27] Another study found that black women had a longer average waiting time for surgery than white women (47 vs. 33 days, $P<0.001$), even after controlling for insurance coverage and clinical factors.[28] Disparities in treatment delays are concerning because breast cancer patients with longer times to treatment have decreased survival rates compared to patients with shorter times to treatment.[27] Furthermore, the relationship between time to breast cancer treatment and survival is more pronounced in black women compared to white women.[27]

Previous studies have suggested that the disparities in care may exist because, on average, black Americans have lower socioeconomic status (SES) and access to health care compared to white Americans.[29,30] However, the disparities in receipt of treatment, time to treatment and thus, survival, between black and white women is not eliminated even after controlling for insurance coverage, access to medical care, and area-level SES.[24,28,31,32] For example, in one national study conducted only among Medicare recipients (*i.e.*, uniform insurance coverage), white women were more likely to receive radiotherapy after breast-conserving surgery compared to black women (OR=1.48, 95%

CI 1.34-1.63), after adjusting for other covariates.[31] Furthermore, according to 2000 to 2010 national data, blacks had the greatest area-level access to healthcare resources (*i.e.*, greatest average number of oncology hospitals, medical doctors, and Ob/Gyns per million population in the county) compared to women of all other races.[32]

Prior investigations of disparities in receipt of treatment found no associations between race and self-decision of surgery.[28] This suggest that inequalities in breast cancer treatment may be the result of factors other than individual medical decisions, insurance coverage, or access to medical care.

1.4 Role of Health Care Facility

Previous studies have suggested that the quality of breast cancer treatment and disparities in treatment may be related to the actual health care facilities in which minority patients are seeking care.[33] There is evidence that disparities in survival exist for black and white women treated in the same health care systems.[9] Additionally, racial disparities in treatment may be more pronounced in certain types of health care systems.[25,34,35]

As previously reported, multiple studies have shown that black breast cancer patients are less likely to receive lymph node biopsy (LNB) or sentinel lymph node biopsy (SLNB) as part of surgical therapy compared to white patients.[25,35] In one study, a higher proportion of those that received LNB were treated at National Cancer Institute (NCI)-designated comprehensive cancer centers.[35] Other studies have shown that patients who receive SLNB are more likely to be treated at an institution affiliated with a research network, such as the American College of Surgeons Oncology Group (ACOSOG) or

other NCI cooperative research groups.[25,34] Moreover, patients who receive SLNB are more likely to be treated by a NCI Comprehensive Community Oncology Program (CCOP) physician than a non-CCOP physician (OR=2.68; 95% CI 1.35-5.34).[36] The magnitude of the association between receipt of SLNB and CCOP physicians is even larger among patients treated in medical school-affiliated hospitals (OR=1.76; 95% CI 1.30–2.39).[36]

There is also evidence that a higher proportion of those who do not receive LNB are treated at low-volume hospitals and community hospitals.[35] However, one study found that black women were not less likely than white women to be treated at a high-volume hospital (OR=0.85; 95% CI 0.54-1.34).[20] These data indicate that such disparities may be the result of complex intersections between race and facility characteristics, such as annual patient volume. Irrespective of race, a nationwide study found that higher annual hospital volume was associated with decreased surgical mortalities.[37]

The observed treatment disparities may be exacerbated by the fact that there is a higher proportion of white patients treated in NCI-designated comprehensive cancer centers, high-breast cancer volume hospitals, and facilities with hospitals with greater affiliations with the ACOSOG, other NCI research cooperative groups, and the NCI's CCOP.[34,36,20]

Similarly, there is emerging evidence that black women are less likely to have specific treatments recommended to them compared to white women. For example, in one study, black women were half as likely to have surgery recommended as a part of their treatment plan for invasive breast cancer compared to white women.[22] This suggests that disparities may partially originate from interpersonal physician-patient interactions.

1.5 Significance of Thesis

Previous studies have recognized that racial disparities in breast cancer outcomes may be partially attributed to disparities in treatment delays, as well as characteristics of the facility in which women received treatment. Additionally, previous studies have recognized that facility characteristics are associated with variations in receipt of different breast cancer treatment methods. However, previous studies have not explored whether facility characteristics are associated with delays in treatment and ultimately, survival disparities. To minimize the existing disparities in breast cancer mortality, it is important to investigate which types of treatment facilities are associated with increased racial disparities in breast cancer outcomes. This project investigates the association between the type of health care institution that women receive breast cancer treatment at and the magnitude of the racial disparity between delays to surgical treatment and breast cancer-specific mortality. The overarching goal of this thesis is to evaluate what types of health care facilities are associated with increased disparities in breast cancer outcomes. Specifically, we aim to (1) describe surgical treatment delays by patient and facility characteristics. Additionally, we will assess (2) the association between facility characteristics and surgical treatment delays and (3) the association between facility characteristics and breast cancer-specific mortality. Both analytic assessments will explore interactions with race.

Research Goal:

To evaluate what types of health care facilities are associated with increased disparities in breast cancer outcomes.

Specific Aims:

Aim 1: To describe delay by patient and facility characteristics
Aim 2: To determine the association between facility characteristics and delay

- Explore interactions with race

Aim 3: To determine the association between facility characteristics and mortality

- Explore interactions with race

CHAPTER II: AN INVESTIGATION OF THE ASSOCIATION BETWEEN RACIAL DISPARITIES IN BREAST CANCER TREATMENT OUTCOMES AND FACILITY CHARACTERISTICS

2.1 Abstract

Previous epidemiologic studies have found that racial disparities in breast cancer-specific mortality are partially attributed to increased surgical delays for black women compared to white women, even after controlling for insurance coverage and access to care. Previous studies have also found that racial disparities in breast cancer outcomes may be partially attributed to the facility in which women receive treatment. No previous studies have investigated whether the racial disparities in treatment delays and mortality are associated with facility-level characteristics. The current study investigates which facility characteristics are associated with increased racial disparities in surgical delays for breast cancer treatment and in breast cancer-specific mortality. Logistic regression was used to model facility characteristics and treatment delay. Cox proportional hazard regression was used to model facility characteristics and mortality. Interactions by patient race was assessed for both associations. The final sample included 3,857 white and 2,341 black women from 35 Metro Atlanta surgical facilities. The median surgical delay was higher in black women (36.0; SD=50.69) compared to white women (29.0; SD=26.50). The largest disparities in delay between white and black women were among patients with Medicare, patients treated in low or moderate volume facilities, government facilities, or facilities with an ACOSOG affiliation. Facilities without a medical school affiliation had lower odds of surgical delay for white patients (aOR=0.89, 95% CI: 0.71, 1.11), but higher odds among black patients (aOR=1.11, 95% CI: 0.92, 1.34). Government (aOR=0.72, 95% CI: 0.66, 0.79) and for-profit hospitals (aOR=0.72, 95% CI: 0.81, 0.89) had lower odds of surgical delay compared to non-profit hospitals. High facility volume was inversely associated with mortality among white patients (aHR=0.60, 95% CI: 0.44, 0.83), yet positively associated among black patients (aHR=1.32, 95% CI: 0.85, 2.05). COC-accreditation was inversely associated with mortality among white patients (aHR=0.69, 95% CI: 0.38, 1.17), yet positively associated among black patients (aHR=1.18, 95% CI: 0.74, 1.88). Future studies with larger samples of patients, which can obtain surgical delay and breast cancer-specific mortality should continue to investigate the associations between various facility characteristics and patient outcomes.

2.2 Introduction

Breast cancer-related mortality rates have continuously improved over the past few decades due to advancements in early detection and treatment methods, but racial disparities in breast cancer outcomes between black and white women have steadily increased.[1] Compared to white women, black women have a two-fold higher chance of

dying from invasive breast cancer despite their lower incidence of the disease. [21] While disparities are, in part, due to late stage at diagnosis and aggressive tumor biology among black women, several epidemiologic studies have provided evidence that the racial disparity in breast cancer outcomes is partially due to disparities in the receipt of breast cancer treatment.[27] For example, black patients are also more likely to experience delays in breast cancer treatment compared to white women. These variations in treatment are associated with poorer outcomes and remain after controlling for insurance coverage and access to care. [20,22,26-28]

Previous epidemiologic studies have also found that racial disparities in breast cancer outcomes may be partially attributed to the facility in which women receive treatment.[20] There is evidence that disparities in survival exist for black and white women treated in the same health care systems,[9] and that certain characteristics of treatment facilities, such as accreditations or annual patient volume, are associated with the odds of receiving treatment.[25,33-36] Additionally, racial disparities in treatment may be more pronounced in certain types of health care systems. [25,34,35] Treatment disparities may also be exacerbated by the fact that there is a higher proportion of white patients treated in facilities with certain beneficial characteristics, such as NCI-designations, high-breast cancer volume, and affiliations with the ACOSOG, other NCI research cooperative groups, and the NCI's CCOP.[34,36,20]

No previous studies have investigated whether the racial disparities in treatment delays and mortality are associated with characteristics of the treatment facility in which patients receive breast cancer treatment. The current study investigates which types of treatment facilities are associated with increased racial disparities in surgical delays for

breast cancer treatment and in breast cancer-associated mortality, which may be informative for minimizing existing breast cancer mortality disparities.

2.3. Methods

2.3.1 Study design and population

This study utilized a prospective cohort study design. Patient data came from the Georgia Cancer Registry and facility data came from the NIH SEER-Medicare database. The Georgia Cancer Registry (GCR) is a statewide population-based registry that has collected all cancer cases diagnosed among Georgia residents since January 1, 1995. The SEER-Medicare database reflects linkages on two large population-based sources of data, the Surveillance, Epidemiology and End Results (SEER) program and Medicare claims for covered health care services. We used data on non-Hispanic black and non-Hispanic white female patients who were diagnosed with primary breast cancer between January 2010 and December 2014. This study restricted to patients with stage I-III breast cancer who received surgical treatment on their primary cancer site at healthcare facilities located in metro Atlanta. This study also excluded patients who received neoadjuvant therapy, where time-to-surgery (*i.e.*, delay) is more variable (Figure 1).

2.3.2 Exposure assessment

Surgical facilities were described by the following characteristics: annual volume of patients (surgical, overall cancer, breast cancer), facility type (voluntary non-profit, for-profit [proprietary], government [state or local], government [federal], academic), accreditations and affiliations (COC, NCI Designated Cancer Center, ACOSOG). These variables were obtained using NCI hospital files from the NIH SEER-Medicare database

with unencrypted facility identifiers. The hospital files are derived from Medicare claims and each hospital is assigned a unique provider number. Detailed information about each hospital is obtained from various sources, including the Healthcare Cost Report (HCRIS) and the Provider of Service (POS) survey from the Center for Medicare and Medicaid Services (CMS).[38]

2.3.3 Outcome assessment

Surgical delay and breast cancer-specific mortality were modeled on continuous and dichotomous scales. Surgical delay is defined as the number of days between the date of cancer diagnosis to the date of treatment initiation (first surgery). Breast cancer-specific death was determined from death certificates using ICD-9 and ICD-10 codes.

2.3.4 Statistical analysis

Logistic regression was used to estimate the multivariable-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) between each facility-level factor and treatment delay. Cox proportional hazard regression was used to estimate the multivariable-adjusted hazard ratios (HRs) and 95% CIs between each facility-level characteristic and mortality. We assessed effect measure modification by patient race on the multiplicative scale using likelihood ratio tests (LRT) with interaction terms included in the model and stratum-specific effect estimates reported. Covariates were selected based on causal graphical analyses (*i.e.,* DAG) and include age, race (black or white), patient insurance type (private, uninsured, Medicaid, Medicare, military, other/unknown), cancer stage (I, II, III), ER status (ER+ [including borderline ER], ER-, unknown), tumor molecular subtype (luminal A, luminal B, HER-2, TNBC, unknown), and surgery type (conserving, mastectomy [including radical mastectomies]). All analyses were conducted with SAS

version 9.4 (SAS Institute, Cary, USA). This study was approved by Emory University's Institutional Review Board.

2.4 Results

There were 6,198 women (62.23% white; 37.77% black) from 35 Metro Atlanta surgical facilities in the final analytic sample (median age of 59.0 years). Of the total cohort, 2,939 women had a surgical delay of less than 30 days and 3,259 had a surgical delay of 30 days or greater. Those with a surgical delay of 30 days or greater were more likely to be black, less likely to have Medicare or Medicaid insurance, have early stage breast cancer, and be treated via a mastectomy (Table 1).

The median surgical delay was higher in black women (36.0; SD=50.69) compared to white women (29.0; SD=26.50). The largest differences in delay (10 days or greater difference) between white and black women were among patients with Medicare, patients treated in low or moderate volume facilities, government facilities, or facilities with an ACOSOG affiliation (Table 2). Facilities with high (aOR=1.76, 95% CI: 1.51, 2.05) or moderate (aOR=1.33, 95% CI: 1.23, 1.43) annual volume were associated with higher odds of surgical delay, compared to low volume facilities (Table 3). Compared to facilities with a medical school affiliation, facilities without a medical school affiliation had lower odds of surgical delay (aOR=0.85, 95% CI: 0.74, 0.98). However, when stratified by race, the inverse association remained among white patients (aOR=0.89, 95% CI: 0.71, 1.11), yet was positively associated among black patients (aOR=1.11, 95% CI: 0.92, 1.34). Compared to non-profit hospitals (referent category), government hospitals had 0.72 lower odds of surgical delay (95% CI: 0.66, 0.79) and for-profit

hospitals had 0.84 lower odds of surgical delay (95% CI: 0.81, 0.89). Black women treated in for-profit hospitals had increased odds of delay (aOR=0.88; 95% CI: 0.81, 0.96) compared to white women (aOR=0.84; 95% CI: 0.79, 0.89; p=0.0022). Moreover, black women treated in government hospitals had increased odds of delay (aOR=0.78; 95% CI: 0.66, 0.91) compared to white women (aOR=0.70; 95% CI: 0.62, 0.79; p=0.0022) (Table 3).

Overall adjusted odds ratios for all patients revealed that facilities with high or moderate annual volume were inversely associated with breast cancer mortality (vs. low volume), with high volume having the strongest inverse association (aHR=0.79, 95% CI: 0.61, 1.03) (Table 4). However, when stratified by race, the inverse association was more pronounced among white patients (aHR=0.60, 95% CI: 0.44, 0.83). Moreover, high volume and mortality were positively associated among black patients (aHR=1.32, 95% CI: 0.85, 2.05). Compared to facilities with a medical school affiliation, facilities without a medical school affiliation had higher risk of mortality (aHR=1.27, 95% CI: 0.98, 1.64). However, we did not identify substantial heterogeneity by race. The aHRs for facility type indicate that women who receive surgical treatment at government (aHR=1.12, 95% CI: 0.94, 1.34) and for-profit (aHR=1.06, 95% CI: 0.97, 1.16) facilities are more likely to die of breast cancer than women receiving treatment at non-profit facilities. Among facility accreditations and affiliations, NCI-designation (aHR=0.61, 95% CI: 0.38, 1.00) and ACOSOG affiliation (aHR=0.86, 95% CI: 0.66, 1.12) are inversely associated with mortality, and aHRs do not differ by patient race (p=0.25). The overall association between COC-accreditation and mortality was close to null (aHR=0.97, 95% CI: 0.68, 1.39). However, when stratified by race, COC-accreditation was inversely associated

with mortality among white patients (aHR=0.69, 95% CI: 0.38, 1.17) and positively associated among black patients (aHR=1.18, 95% CI: 0.74, 1.88), although these estimates were not substantially different.

2.5 Discussion

The findings from this study revealed interaction by race in the association between facility type and surgical delay. However, there was no interactions by race in the association between any facility characteristics and breast cancer-related mortality, potentially due to low mortality counts in each cell (Table 4). However, there were some interesting trends in the association between breast cancer-related mortality and facility characteristics that should be investigated in future studies. For example, some of the stratum-specific estimates for mortality suggest that certain facility characteristics that should be beneficial to patient outcomes in general, such as COC-accreditation and high patient volume[37], may be disproportionately inversely associated among white breast cancer patients, and sometimes positively associated among black breast cancer patients. These findings may support previous literature that have found that disparities in survival exist for black and white women treated in the same health care systems.[9] Thus, the findings from this study suggest that facilities that have qualities that are intended or expected to be beneficial to their patients, may not be beneficial to all patients.

2.5.1 Strengths and limitations

A strength of this study was its large overall sample size. However, a limitation was that certain subcategories were underrepresented, such as non-luminal A subtype patients, stage III cancer patients, uninsured patients, Medicaid patients, and patients with

military insurance. Further, the number of patients who experienced surgical delays and breast cancer-specific mortality were relatively sparse.

2.5.2 Conclusions

The findings from this study suggest that there are associations between several facility characteristics and surgical delays and breast cancer-specific mortality. Moreover, our findings suggest that race may modify the association between facility type and surgical delay. Future studies with larger numbers of patients with surgical delays and breast cancer-specific mortality should continue to investigate the associations between patient outcomes and various facility characteristics.

CHAPTER III: SUMMARY, PUBLIC HEALTH IMPLICATIONS, POSSIBLE FUTURE DIRECTIONS

The present study addressed a gap in the literature regarding whether racial disparities in breast cancer treatment delays and mortality could be explained by facility-level characteristics. This study found that some facility characteristics that are generally beneficial to patient populations may only be beneficial to white patients, and even associated with negative outcomes among black patients. This suggests that facilities may need to stratify their quality assurance evaluations by patient demographics and ensure that all patients are benefiting from the facility's assets. Further research should investigate additional facility characteristics or expand analyses beyond Metro Atlanta (*i.e.*, compare rural and urban facilities). Additionally, it may be important to investigate physician-patient interactions (*e.g.*, surgical recommendations, aggressiveness in treatment). Previous studies have found that black women are less likely to have specific treatments recommended to them compared to white women. For example, in one study, black women were half as likely to have surgery recommended as a part of their treatment plan for invasive breast cancer compared to white women.[22] This suggests that disparities may partially originate from interpersonal physician-patient interactions.

When stratified by facility characteristics, the number of patients that experienced surgical delays and breast cancer-specific mortality were sparse in this study. Future studies that specifically investigate the associations between various facility-level characteristics and racial disparities in patient outcomes may have more robust findings.

3.1 Appendices

Figure 1

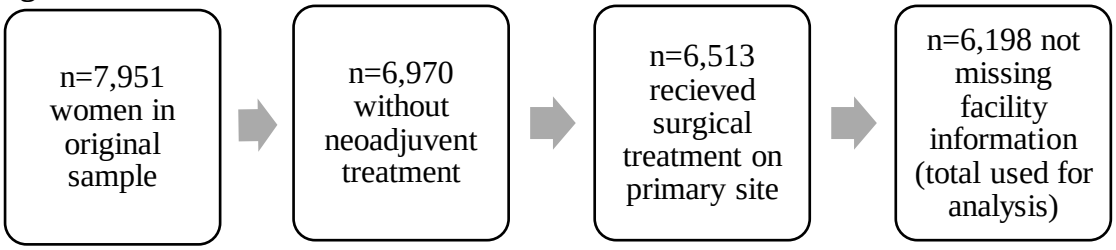

Table 1: Surgical delay (dichotomous) for all modalities

	Overall n=6,198	**< 30 days from diagnosis** n=2,939	**≥ 30 days from diagnosis** n=3,259
Patient characteristics	**Median (SD)**	**Median (SD)**	**Median (SD)**
Age at diagnosis	59.00 (12.65)	59.00 (12.83)	59.00 (12.48)
	n (col %)	**n (%)**	**n (%)**
Race			
White	3,857 (62.23)	2,002 (68.12)	1,855 (56.92)
Black	2,341 (37.77)	937 (31.88)	1,404 (43.08)
Breast cancer-specific death			
Insurance type	203 (3.28)	117 (3.98)	86 (2.64)
Private			
Uninsured	3,832 (61.83)	1,803 (61.35)	2,029 (62.26)
Medicaid	93 (1.50)	42 (1.43)	51 (1.56)
Medicare	371 (5.99)	178 (6.06)	193 (5.92)
Military	1,765 (28.48)	861 (29.30)	904 (27.74)
Other/unknown	62 (1.00)	23 (0.78)	39 (1.20)
	75 (1.21)	32 (1.09)	43 (1.32)
Cancer stage			
I	3,690 (59.54)	1,716 (58.39)	1,974 (60.57)
II	2,014 (32.49)	932 (31.71)	1,082 (33.20)
III	494 (7.97)	291 (9.90)	203 (6.23)
ER status			
ER +	5,292 (85.38)	2,451 (83.40)	2,841 (87.17)
ER –	875 (14.12)	468 (15.92)	407 (12.49)
Unknown	31 (0.50)	20 (0.68)	11 (0.34)
Tumor molecular subtype			
Luminal A	4,408 (71.12)	2,020 (68.73)	2,388 (73.27)
Luminal B	631 (10.18)	303 (10.31)	328 (10.06)
HER-2	201 (3.24)	102 (3.47)	99 (3.04)
TNBC	579 (9.34)	319 (10.85)	260 (7.98)
Unknown	379 (6.11)	195 (6.63)	184 (5.65)
Surgery type[1]			
Conserving	3,515 (56.71)	1,855 (63.12)	1,660 (50.94)
Mastectomy	2,682 (43.29)	1,083 (36.85)	1,599 (49.06)

Facility characteristics			
Annual patient discharge			
Low (<19,835)	938 (15.13)	462 (15.72)	476 (14.61)
Moderate (19,835-29,711)	1,919 (30.96)	1,007 (34.26)	912 (27.98)
High (>29,711)	2,610 (42.11)	1,124 (38.24)	1,486 (45.60)
Unknown	7311(11.79)	346 (11.77)	385 (11.81)
Medical school affiliation			
Yes	998 (16.10)	444 (15.11)	554 (17.00)
No	4,516 (72.86)	2,174 (73.97)	2,342 (71.86)
Unknown	684 (11.04)	321 (10.92)	363 (11.14)
Facility type			
Non-profit	4,351 (70.20)	1,896 (64.51)	2,455 (75.33)
For-profit	429 (6.92)	249 (8.47)	180 (5.52)
Government	734 (11.84)	473 (16.09)	261 (8.01)
Unknown	684 (11.04)	321 (10.92)	363 (11.14)
Accreditations or affiliations			
COC-accredited			
Yes	5,892 (95.06)	2,814 (95.75)	3,078 (94.45)
No	306 (4.94)	125 (4.25)	181 (5.55)
NCI Center			
Yes	330 (5.32)	149 (5.07)	181 (5.55)
No	5,868 (94.68)	2,790 (94.93)	3,078 (94.45)
ACOSOG affiliation			
Yes	822 (13.26)	375 (12.76)	447 (13.72)
No	5,376 (86.74)	2,564 (87.24)	2,812 (86.28)

[1] Surgery type: Unknown
Overall: n=1 (0.02%)
<30 days from diagnosis: n=1 (0.03%)

Table 2: Surgical delay (continuous) for all modalities by patient race

	Median delay in days (SD)	
	White (n=3,857)	**Black** (n=2,341)
Overall delay	29.0 (26.50)	36.0 (50.69)
Patient characteristics		
Age at diagnosis		
< age 55	30.0 (22.67)	35.0 (34.40)
≥ age 55	29.0 (28.38)	38.0 (60.20)
Insurance type		
Private	30.0 (22.77)	36.0 (32.32)
Uninsured	29.0 (21.17)	34.0 (40.63)
Medicaid	29.5 (31.57)	33.0 (35.29)
Medicare	28.0 (32.83)	38.0 (84.61)
Military	33.5 (19.27)	37.5 (23.54)
Other/unknown	33.0 (23.44)	39.5 (52.11)
Cancer stage		
I	29.0 (26.41)	38.0 (61.35)
II	30.0 (22.89)	36.0 (34.56)
III	25.0 (39.33)	20.0 (35.95)
ER status		
ER +	30.0 (26.72)	37.0 (34.85)
ER –	26.0 (22.40)	33.0 (30.82)
Tumor molecular subtype		
Luminal A	31.0 (27.51)	37.0 (35.23)
Luminal B	28.0 (21.62)	36.0 (31.21)
HER-2	28.5 (22.52)	32.0 (35.43)
TNBC	25.0 (22.61)	31.0 (29.61)
Surgery type		
Conserving	27.0 (25.90)	34.0 (32.15)
Mastectomy	35.0 (26.87)	40.0 (67.62)
Facility characteristics		
Annual discharge		
Low	27.0 (40.50)	38.0 (41.77)
Moderate	23.0 (24.17)	35.0 (66.60)
High	33.0 (24.22)	38.0 (25.99)
Medical school affiliation		
Yes	31.0 (26.50)	35.0 (34.89)
No	29.0 (27.34)	37.0 (58.21)
Facility type		
Non-profit	32.0 (24.62)	37.0 (53.56)
For-profit	27.0 (50.18)	29.0 (41.18)
Government	19.0 (19.81)	34.5 (49.14)
Accreditations or affiliations		
COC-accredited		
Yes	29.0 (26.54)	36.0 (51.10)
No	29.0 (24.84)	38.0 (45.90)
NCI Designated Cancer Center		
Yes	33.0 (28.34)	39.0 (40.33)
No	29.0 (26.38)	36.0 (51.22)
ACOSOG Affiliation		
Yes	28.0 (26.86)	40.0 (99.53)
No	30.0 (26.46)	36.0 (34.18)

Table 2 Supplement: Surgical delay (dichotomous) for all modalities by patient race

Patient characteristics	< 30 days from diagnosis		≥ 30 days from diagnosis	
	White	**Black**	**White**	**Black**
	Median (SD)	Median (SD)	Median (SD)	Median (SD)
Age at diagnosis	61.0 (12.77)	60.0 (12.60)	56.0 (12.38)	58.0 (12.22)

	< 30 days from diagnosis		≥ 30 days from diagnosis	
	White	**Black**	**White**	**Black**
	n (%)	n (%)	n (%)	n (%)
Insurance type				
Private	1,254 (62.64)	549 (58.59)	1,215 (65.50)	814 (57.98)
Uninsured	17 (0.85)	25 (2.67)	15 (0.81)	36 (2.56)
Medicaid	43 (2.15)	135 (14.41)	41 (2.21)	152 (10.83)
Medicare	658 (32.87)	203 (21.66)	547 (29.49) 15	357 (25.43)
Military	9 (0.45)	14 (1.49)	(0.81)	24 (1.71)
Other/ unknown	21 (1.05)	11 (1.17)	22 (1.19)	21 (1.50)
Cancer stage				
I	1,278 (63.84)	438 (46.74)	1,186 (63.94)	788 (56.13)
II	574 (28.67)	358 (38.21)	566 (30.51)	516 (36.75)
III	150 (7.49)	141 (15.05)	103 (5.55)	100 (7.12)
ER status[1]				
ER +	1,755 (87.66)	696 (74.28)	1,702 (91.75)	1,139 (81.13)
ER –	232 (11.59)	236 (25.19)	149 (8.03)	258 (18.38)
Unknown	15 (0.75)	5 (0.53)		7 (0.50)
Tumor molecular subtype				
Luminal A	1,460 (72.93)	560 (59.77)	1,463 (78.87)	925 (65.88)
Luminal B	199 (9.94)	104 (11.10)	167 (9.00)	161 (11.47)
HER-2	52 (2.60)	50 (5.34)	46 (2.48)	53 (3.77)
TNBC	151 (7.54)	168 (17.93)	89 (4.80)	171 (12.18)
Unknown	140 (6.99)	55 (5.87)	90 (4.85)	94 (6.70)
Surgery type[2]				
Conserving	1,290 (64.44)	565 (60.30)	896 (48.30)	764 (54.42)
Mastectomy	712 (35.56)	371 (39.59)	959 (51.70)	640 (45.58)
Facility characteristics				
Annual discharge				
Low	279 (13.94)	183 (19.53)	193 (10.40)	283 (20.16)
Moderate	580 (28.97)	427 (45.57)	326 (17.57)	586 (41.74)
High	914 (45.65)	210 (22.41)	1,092 (58.87)	394 (28.06)
Unknown	229 (11.44)	117 (12.49)	244 (13.15)	141 (10.04)
Medical school affiliation				
Yes	168 (8.39)	276 (29.46)	169 (9.11)	385 (27.42)
No	1,605 (80.17)	569 (60.73)	1,446 (77.95)	896 (63.82)
Unknown	229 (11.44)	92 (9.82)	240 (12.94)	123 (8.76)
Facility type				
Non-profit	1,272 (63.54)	624 (66.60)	1,409 (75.96)	1,406 (74.50)
For-profit	161 (8.04)	88 (9.39)	100 (5.39)	80 (5.70)
Government	340 (16.98)	133 (14.19)	106 (5.71)	155 (11.04)
Unknown	229 (11.44)	92 (9.82)	240 (12.94)	123 (8.76)

Accreditations or affiliations				
COC-accredited				
Yes	1,952 (97.50)	862 (92.00)	1,809 (97.52)	1,269 (90.38)
No	50 (2.50)	75 (8.00)	46 (2.48)	135 (9.62)
NCI Designated Cancer Center				
Yes	95 (4.75)	54 (5.76)	110 (5.93)	71 (5.06)
No	1,907 (95.25)	883 (94.24)	1,745 (94.07)	1,333 (94.94)
ACOSOG Affiliation				
Yes	242 (12.09)	133 (14.19)	207 (11.16)	240 (17.09)
No	1,760 (87.91)	804 (85.81)	1,648 (88.84)	1,164 (82.91)

[1] ER status: Unknown
Whites ≥30 days: n=4 (0.22%)

[2] Surgery type: Unknown
Blacks <30 days: n=1 (0.11%)
Whites ≥30 days: n=1 (0.05%)

Table 3. Multivariable adjusted odds ratios[1] estimating the association between facility characteristics and surgical treatment delays overall, and stratified by patient race

	Overall delay (n)	White delay (n)	Black delay (n)	Overall aOR (95% CI)	White aOR (95% CI)	Black aOR (95% CI)	Multiplicative interaction *p*-value
Annual discharge							
Low	476	193	283	(referent)	(referent)	(referent)	0.0962
Moderate	912	326	586	1.33 (1.23, 1.43)	1.48 (1.34, 1.63)	1.11 (0.98, 1.26)	
High	1,486	1,092	394	1.76 (1.51, 2.05)	2.18 (1.80, 2.65)	1.23 (0.96, 1.58)	
Med school affiliation[2]							
Yes	554	169	385	(referent)	(referent)	(referent)	0.2675
No	2,342	1,446	896	0.85 (0.74, 0.98)	0.89 (0.71, 1.11)	1.11 (0.92, 1.34)	
Facility type[2]							
Non-profit	2,455	1,409	1,046	(referent)	(referent)	(referent)	0.0022
For-profit	180	100	80	0.84 (0.81, 0.89)	0.84 (0.79, 0.89)	0.88 (0.81, 0.96)	
Govt.	261	106	155	0.72 (0.66, 0.79)	0.70 (0.62, 0.79)	0.78 (0.66, 0.91)	
Accreditations or affiliations[3]							
COC	3,078	1,809	1,269	0.74 (0.58, 0.93)	1.00 (0.66, 1.50)	0.80 (0.59, 1.06)	0.1287
NCI	181	110	71	1.11 (0.89, 1.39)	1.27 (0.97, 1.70)	0.88 (0.16, 1.27)	0.4921
ACOSOG	447	207	240	1.10 (0.95, 1.23)	0.92 (0.76, 1.12)	1.25 (0.99, 1.57)	0.0630

[1] Controlling for age, insurance, and stage
[2] n=363 missing
[3] Referent categories are non-COC, non-NCI, and non-ACOSOG

Table 4: Multivariable adjusted hazard ratios[1] estimating the association between facility characteristics and breast cancer-related mortality overall, and stratified by patient race

	Overall mortality (n)	White mortality (n)	Black mortality (n)	Overall aHR (95% CI)	White aHR (95% CI)	Black aHR (95% CI)	*p*-value
Annual discharge[2]							
Low	34	15	19	(referent)	(referent)	(referent)	p=0.2156
Moderate	74	23	51	0.89 (0.78, 1.01)	0.78 (0.66, 0.91)	1.15 (0.93, 1.43)	
High	75	46	29	0.79 (0.61, 1.03)	0.60 (0.44, 0.83)	1.32 (0.85, 2.05)	
Med school affiliation[2]							
Yes	40	4	36	(referent)	(referent)	(referent)	p=0.4880
No	148	80	68	1.27 (0.98, 1.64)	1.73 (1.02, 2.91)	1.12 (0.82, 1.52)	
Facility type[3]							
Non-profit	144	59	85	(referent)	(referent)	(referent)	p=0.9892
For-profit	20	10	10	1.06 (0.97, 1.16)	1.10 (0.98, 1.23)	1.00 (0.87, 1.15)	
Government	24	15	9	1.12 (0.94, 1.34)	1.21 (0.96, 1.51)	1.00 (0.75, 1.33)	
Accreditations or affiliations							
COC	191	88	103	0.97 (0.68, 1.39)	0.69 (0.38, 1.17)	1.18 (0.74, 1.88)	p=0.4784
NCI	9	2	7	0.61 (0.38, 1.00)	0.58 (0.30, 1.12)	0.66 (0.32, 1.34)	p=0.2499
ACOSOG	30	9	21	0.86 (0.66, 1.12)	0.91 (0.63, 1.33)	0.81 (0.55, 1.17)	p=0.2576

[1] Controlled for age, insurance, stage, and ER status
[2] n=20 missing
[3] n=15 missing

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