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PRECLINICAL STUDY

Racial disparities in breast cancer persist despite early detection: analysis of treatment of stage 1 breast cancer and effect of insurance status on disparities

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Abstract

Purpose Prior research demonstrates racial disparities in breast cancer treatment. Disparities are commonly attributed to more advanced stage at presentation or aggressive tumor biology. We seek to evaluate if racial disparities persist in the treatment of stage 1 breast cancer patients who by definition are not delayed in presentation.

Methods We selected stage 1 breast cases in the National Cancer Data Base. Patients were divided into two cohorts based on race and included White and Black patients. We also performed a subgroup analysis of patients with private insurance for comparison to determine if private insurance diminished the racial disparities noted. We analyzed differences in time to treatments by race.

Results Our analysis included 546,351 patients of which 494,784 (90.6%) were White non-Hispanic and 51,567 (9.4%) were Black non-Hispanic. Black women had significantly longer times to first treatment (35.5 days vs 28.1 days), surgery (36.6 days vs 28.8 days), chemotherapy (88.1 days vs 75.4 days), radiation (131.3 days vs 99.1 days), and endocrine therapy (152.1 days vs 126.5 days) than White women. When patients with private insurance were analyzed the difference in time to surgery decreased by 1.2 days but racial differences remained statistically significant.

Conclusions Despite selecting for early-stage breast cancer, racial disparities between White and Black women in time to all forms of breast cancer treatment persist. These disparities while likely not oncologically significant do suggest institutional barriers for obtaining care faced by women of color which may not be addressed with improving access to mammography alone.

Keywords Breast cancer · Early stage · Racial disparities · Time to surgery · Time to treatment · National Cancer Data Base

Abbreviations

SEER	Surveillance, Epidemiology, and End Results
ER	Estrogen receptor
NCDB	National Cancer Data Base
CoC	Commission on Cancer
AJCC	American Joint Committee on Cancer
NBCCEDP	National Breast and Cervical Cancer Early Detection Program

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Introduction

Breast cancer is the most frequently diagnosed non-skin cancer in women and is the second most common cause of deaths from cancer in women in the United States [1]. In 2010, Americans spent approximately $125 billion on cancer care. Breast cancer spending made up 13% of direct medical costs on cancer in 2010 for a total of $16.5 billion [2].

While the incidence of breast cancer is higher in the White population compared to Black population (125.4 vs 116.1 diagnoses per 100,000 women), the mortality rate for Black women with breast cancer is higher than for White women [3–5]. This mortality gap is worsening over time despite advances in treatment of breast cancer [5]. Horner and colleagues showed in a Surveillance, Epidemiology, and End Results (SEER) data review that from 1975 to 2006 White women have had a 28% decrease in mortality from breast cancer, while Black women had a 6% increase

in breast cancer mortality over the same time period [6]. Compounding these disparities are more aggressive tumor biology subtypes in non-White women. Black women are diagnosed with breast cancer at a younger age, have higher rates of estrogen receptor (ER) negative tumors, on average have higher grade tumors and have more advanced stage of disease at presentation [5, 7–9]. It has previously been shown that Black women have lower rates of breast conserving surgery, lower rates of breast reconstruction after mastectomy, and less use of adjuvant radiation and chemotherapy [10, 11]. Non-White patients are also more prone to be treated not in accordance with established guidelines [5].

Extensive prior research has shown grave racial and socioeconomic disparities in the diagnosis, treatment, and outcomes of patients with breast cancer [5, 11–16]. However, much of the differences in treatments and outcomes are related to the later stage of presentation in minority women with breast cancer.

The majority of Stage 1 (T1, N0, M0 & T0 or T1, N1mic, M0) breast cancers are diagnosed by screening mammogram. Stage 1 patients are not delayed in presentation almost by definition. Since 1987 mammography screening has increased considerably among all racial groups. This had resulted in more frequent diagnoses of early-stage breast cancer [17]. Rates of screening remain substantially lower among poor and near-poor women versus non-poor women. In 2008, 51.4% of poor women had undergone screening mammography versus 72.8% of non-poor women [3]. Despite the fact that rates of screening mammography are approximately equal between Black and White patients, breast cancer mortality rates in Black patients did not drop in similar fashion as to what has been observed in White women [18, 19].

We seek to evaluate if racial disparities persist in the treatment of stage 1 breast cancer patients who by definition are not delayed in presentation and many of whom participated in mammogram screening.

Methods

A retrospective review of stage 1 breast cancer cases from 2004 to 2014 was undertaken using the National Cancer Data Base (NCDB). The National Cancer Data Base was started in 1985 as a joint project of the American College of Surgeons Commission on Cancer (CoC) and the American Cancer Society. It is a national oncology database and contains over 30 million records from CoC cancer hospital registries. It includes 70% of all new cancer cases in the United States from more than 1500 individual cancer programs [11, 20].

Inclusion criteria assessed female patients aged 18 years and older with Stage 1 breast cancer according to American Joint Committee on Cancer (AJCC) pathological staging. Patients were divided into two cohorts based on race and included White and Black patients. Patients with Spanish or Hispanic origin and other racial groups were excluded from the analysis in order to simplify statistical analysis. We also performed a subgroup analysis of patients with private insurance for comparison to determine if private insurance diminished the racial disparities noted. Non-private insurance included Medicaid, Medicare, or other government insurance.

We hypothesized that treatment for stage 1 breast cancer for the majority of patients would begin with surgical treatment though we acknowledge a small minority of Stage 1 breast cancer patients do undergo neoadjuvant chemotherapy. This includes those with triple negative disease, HER2 positive disease who we expect to be disproportionally Black or those small breasted patients trying to downsize a tumor to improve the cosmetic result of breast conserving therapy. We hypothesized that neoadjuvant chemotherapy would extend the interval of time from diagnosis to surgical treatment and possibly confound our results. We therefore also excluded all patients that were classified by the NCDB as undergoing systemic therapy before surgery as well as those that underwent systemic therapy before and after surgery (such as in HER2 positive tumors).

The following information was extracted from the NCDB: age, median household income as determined by zip code, primary insurance carrier, type of treatment facility, distance in miles between the patient's residence and treating facility, and Charlson/Deyo comorbidity score. We compared outcome variables including rates of ER negative tumors, use of chemotherapy, time to first treatment, time to surgery (lumpectomy or mastectomy), time to chemotherapy, time to radiation therapy, and time to hormonal therapy. Time to treatment was defined as the number of days between the date of diagnosis and the date on which treatment [surgery, radiation, systemic, or other therapy] of the patient began.

The two cohorts (White vs Black patients) were compared with respect to the variables above. We used chi-squared tests for categorical variables and Student *t* test or Mann–Whitney *U* test for continuous variables. A multiple linear regression analysis was performed for time to surgery to determine the impact of race while controlling for the following factors: insurance status, median quartile income, great circle distance, Charlson/Deyo score, and surgical procedure of the primary site (mastectomy vs breast reconstruction). We did not control for radiation in our regression. Overall survival was estimated by the Kaplan–Meier method using the number of months between the date of diagnosis and the date on which the patient was last contacted or died. The log-rank test was used to determine the differences in survival curves. An alpha level of 0.05 was used for all significance tests. The data were analyzed using IBM SPSS

software (version 22.0). Institutional Review Board approval was obtained from our institution for this analysis.

Results

There were 628,104 female Stage I breast cancer patients in the NCDB. Our analysis included 546,351 patients of which 494,784 (90.6%) were White non-Hispanic and 51,567 (9.4%) were Black non-Hispanic. 81,753 patients were excluded as they were Hispanic, other racial groups or unknown race.

Black women were younger compared to White women and more lived in counties with median income < $30,000. Black women lived closer to the treating hospital. Patients with significant co-morbidities (Charlson/Deyo score ≥ 2) were rare in both groups but were more common in Black patients. ER negative tumors were more common in Black women. Black women underwent chemotherapy more frequently than White women. Black women had significantly longer times to first treatment (35.5 days vs 28.1 days), time to surgery (36.6 days vs 28.8 days), chemotherapy (88.1 days vs 75.4 days), radiation (131.3 days vs 99.1 days), and endocrine therapy (152.1 days vs 126.5 days) than White women. The difference in time to surgery in this group was 7.8 days (see Table 1).

When patients with private insurance were analyzed Black women were still younger than White women. Patients with significant co-morbidities were even rarer in this group but were still significantly more frequent in Black patients. Despite private insurance Black women still had longer time to surgery versus White patients (35.2 days vs 28.6 days). The difference in time to surgery in this group was 6.6 days. The time to treatment in the private insurance group was longer in Black patients versus White patients (33.9 days vs 27.7 days) (see Table 2).

Table 1 Characteristics of stage 1 breast cancer patients, all-insurance cohort

	White	Black	*P*-value	Δ (days)
Age (years)	62.0	59.5	< 0.001	
Median income < $30,000	7.1%	27.1%	< 0.001	
Great circle distance (miles)	23.1	14.5	< 0.001	
Charlson/Deyo score ≥ 2	2.2%	3.9%	< 0.001	
Rate of ER negative tumor	12.8%	23.9%	< 0.001	
Use of systemic chemotherapy	21.9%	31.1%	< 0.001	
Time to treatment (days)	28.1	35.5	< 0.001	7.4
Time to surgery (days)	28.8	36.6	< 0.001	7.8
Time to chemotherapy (days)	75.4	88.1	< 0.001	12.7
Time to radiation (days)	99.1	131.3	< 0.001	32.2
Time to hormone therapy (days)	126.5	152.1	< 0.001	25.6

Table 2 Characteristics of stage 1 breast cancer patients, private insurance cohort

	White	Black	*P*-value	Δ (days)
Age (years)	55.0	54.1	< 0.001	
Median income < $30,000	6.0%	22.4%	< 0.001	
Great circle distance (miles)	22.6	15.1	< 0.001	
Charlson/Deyo score ≥ 2	1.1%	2.0%	< 0.001	
Rate of ER negative tumor	13.9%	26.1%	< 0.001	
Use of systemic chemotherapy	28.8%	37.9%	< 0.001	
Time to treatment (days)	27.7	33.9	< 0.001	6.2
Time to surgery (days)	28.6	35.2	< 0.001	6.6
Time to chemotherapy (days)	74.0	85.0	< 0.001	11
Time to radiation (days)	105.5	135.5	< 0.001	30
Time to hormone therapy (days)	136.3	160.6	< 0.001	24.3

A multiple linear regression model, controlling for multiple factors, indicated that the time to surgery for Black patients was 7.5 days longer. The time to surgery was decreased by 1.35 days for patients with private insurance when compared with non-private insurance. Although statistically significant, the difference in miles between the patient's residence and the hospital that reported the case was minimal. The predicted time to surgery for patients with Charlson/Deyo score of greater than and equal to 2 was about 3 days longer and with mastectomy was 6.5 days longer (see Table 3).

In our all-insurance cohort, White women had higher overall survival than Black women as a percentage of population (90.9% vs 90.4% $P < 0.001$) as well as in the number of months surviving since diagnosis (129.8 months vs 126.0 months, $P < 0.001$). When patients with private insurance underwent subgroup analysis White women still demonstrated greater overall survival than Black women as a percentage of population (95.9% vs 94.3%, $P < 0.001$) as well as in the number of months surviving since diagnosis (139.4 months vs 133.1 months, $P < 0.001$).

Discussion

The National Breast and Cervical Cancer Early Detection Program (NBCCEDP) established a metric of making a diagnosis of breast cancer within 60 days of an irregular screening test and beginning treatment in less than 60 days of making a diagnosis. Several organizations recommend that time to treatment should be utilized as a quality metric for breast cancer care, such as the National Quality Measures for Breast Centers program, the National Accreditation Program for Breast Centers, the National Quality Forum, and the American Society of Breast Surgeons [21].

Table 3 Results of multiple regression analysis for factors related to time to surgery

Independent variables	Estimated β	Standard error	95% confidence interval	*P*-value
Intercept	30.41	0.299	29.82 to 30.99	< 0.001
Black	7.50	0.137	7.24 to 7.77	< 0.001
Private insurance	− 1.35	0.101	− 1.55 to − 1.15	< 0.001
Age	− 0.04	0.004	− 0.05 to − 0.04	< 0.001
Income < $30,000	− 1.48	0.139	− 1.75 to − 1.21	< 0.001
Great circle distance	0.001	0.000	0.00 to 0.002	0.025
Charlson/Deyo score ≥ 2	2.93	0.255	2.42 to 3.43	< 0.001
Mastectomy	6.48	0.089	6.3 to 6.65	< 0.001

Several studies have shown that increased time to surgery leads to decreased survival. Bleicher and colleagues showed that survival in early-stage breast cancer is reduced when the duration of time between diagnosis and surgery increases in a population-based study using the SEER database and the NCDB [22]. They showed the effect of time to surgery on overall survival was only statistically significant for Stage I and II patients. Even though the extent of the 5-year survival difference was small (4.6% and 3.1% for ≤ 30 days vs 91–120 days in SEER and NCDB patients, respectively), this benefit is similar to the magnitude of increasing tamoxifen therapy from 5 to 10 years. They concluded that attempts should be made to reduce time to surgery. Other studies have also shown that increased time to surgery leads to decreased survival. Richards and colleagues in a systematic review reported that delays of 3–6 months from beginning of symptoms to starting treatment are associated with decreased survival in patients with breast cancer [23]. Shin and colleagues reported that delays to surgery greater than 12 weeks were associated with decreased survival in breast cancer patients in a cohort study [24].

We found higher overall survival in White women versus Black women in our all-insurance cohort and in our private insurance cohort. In a stage 1 breast cancer population it is unlikely that the breast cancer itself had a significant effect on overall survival. We were unable to report breast cancer specific survival due to the limitation inherent with NCDB data capturing.

Smith and colleagues reported that young patients diagnosed with breast cancer with a delay in surgery of 6 weeks have decreased survival in comparison to women with shorter time to treatment. The negative effect on survival was more prominent in Black patients, those with public insurance, those that did not have any insurance and those with low socioeconomic status [25].

Polverini and colleagues showed that increased time to surgery reduced overall survival for patients with stage I breast cancer in a NCDB database study in women. When stratified by stage, stage I patients treated at 8 to > 12 weeks (HR 1.07, 95% CI 1.02–1.13) and > 12 weeks (HR 1.19, 95% CI 1.11–1.28) had reduced overall survival in comparison to patients treated at < 4 weeks [20].

We found a difference of 7.4 days in time to any treatment in Stage 1 breast cancer between all White and Black women. We found a difference of 7.8 days in time to surgery in Stage 1 breast cancer between all White and Black women. It remains unclear to what extent are the differences in time to treatment and time to surgery in our study reflect *clinically* significant differences in care as opposed to serving as proxies for systematic differences in access to oncology services and patterns of treatment receipt.

Our results are in line with other studies in the literature that found that Black patients were more likely to have delays in surgery for breast cancer. For example, Sheppard and colleagues found that average time to surgery was greater in Black (mean 47 days) than White patients (mean 33 days; $P = 0.001$) in women with primary non-metastatic breast cancer. Black women were not as likely to undergo surgical treatment within 90 days in comparison to White women after adjustments for covariates [21].

Fedewa and colleagues evaluated three groups of treatment delay (> 30, > 60, and > 90 days) after biopsy using the NCDB database. They concluded that Black patients had an increased risk of treatment delay compared to White patients with Stage I–III breast cancer independent of health insurance status, cancer stage at diagnosis, and age [26].

Gorin and colleagues found that Black patients with primary breast cancer had more treatment delay as compared to White women in a population-based study including insured women from the SEER-Medicare database. These disparities were apparent in all stages [18].

It has been shown that Black women had an increased likelihood as compared to White women to not have insurance or have Medicare or Medicaid (46% vs 26%, $P < 0.001$) [19]. Bilimoria and colleagues showed that patients who did not have insurance or with Medicaid insurance were more likely to have longer wait times for breast cancer surgery [27]. Furthermore, Jemal and colleagues published a NCDB based study concluding that differences in insurance explained one-third of the excess risk of death among nonelderly Black versus White women diagnosed with early-stage breast cancer [28]. We

therefore performed a stratified analysis to include only those patients with private insurance in order to eliminate this possible confounder. Despite private insurance Black women still had longer time to surgery versus White patients (35.2 days vs 28.6 days), though the difference was similar to the all-insurance cohort (6.6 vs 7.8 days). Private insurance partially but not completely reduced the disparities in time to surgery.

Sometimes delays in time to surgery may be appropriate or essential as in the situation when coordination with a plastic surgeon is required for reconstruction. This was shown by Sheppard and colleagues as patients who underwent breast conserving surgery had a shorter time to surgery as compared to mastectomy patients [21].

While shorter times to surgery have been demonstrated to reduce patient anxiety and boost satisfaction not to mention improve survival there continues to be more treatment delays in Black women with breast cancer [20]. The majority of our stage 1 breast cancer population presumably is diagnosed by screening mammogram and thereby showing some degree of patient compliance with health screening and treatment. It remains unclear why stage 1 Black women have more delays in time to surgery. It is hard to explain the longer time to radiation among Black women versus White women despite the closer proximity to treating facility.

Longer delays in breast cancer treatment in Black women has been explained by a lack of patient understanding, cultural/psychosocial beliefs, financial restrictions, decreased access to care, ineffective communication between physician and patient, racial discrimination, and system issues [18, 19]. Future research should explore institutional barriers to achieving timely breast cancer care so as to minimize delays when possible.

Conclusions

Despite selecting for early-stage breast cancer, racial disparities between White and Black women in time to all forms of breast cancer treatment persist. The results from this study imply reduced quality of care for Black patients with early-stage breast cancer. These disparities while likely not oncologically significant do suggest institutional barriers for obtaining care faced by women of color which may not be addressed with improving access to mammography alone. This NCDB based research adds to the current literature on racial disparities in time to surgery for Black patients with breast cancer.

Compliance with ethical standards

Conflict of interest Ethan J. Hoppe, Lala R. Hussain, Kevin J. Grannan, Erik M. Dunki-Jacobs, David Y. Lee and Barbara A. Wexelman declare that they have no conflict of interest.

Research involving human participants and/or animals This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was not obtained by the authors from individual participants included in the study as this was an NCDB based study.

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