Race and Site of Care Impact Treatment Delays in Older Women with Non-Metastatic Breast Cancer

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Abstract

Background.—Women 65 years of age are less likely to receive guideline-concordant breast cancer care. Given existing racial/ethnic disparities, older minority breast cancer patients may be especially prone to inequalities in care. How site of care impacts older breast cancer patients is not well defined. We sought to evaluate the association between race/ethnicity and breast cancer treatment delays in older women treated at minority-serving hospitals (MSHs) versus non-MSHs.

Methods.—Women 65 years of age treated for non-metastatic breast cancer were identified in the National Cancer Database (2010–2017). Treatment delay was defined as > 90 days from diagnosis to initial treatment. MSHs were defined as the top decile of hospitals serving predominantly Black or Hispanic patients. Multivariable logistic regression models adjusted for patient, tumor, and hospital characteristics were used to determine the odds of treatment delay for women at MSHs versus non-MSHs across racial/ethnic groups.

Results.—Overall, 557,816 women were identified among 41 MSHs and 1146 non-MSHs. Average time to treatment was 33.71 days (standard deviation 26.92 days). Older women at MSHs were more likely to experience treatment delays than those at non-MSHs (odds ratio 1.28, 95% confidence interval 1.21–1.36). Regardless of where they received care, minorities were more likely to experience treatment delays than non-Hispanic White women.

Conclusions.—Although 97% of older women treated at Commission on Cancer-accredited hospitals received timely breast cancer care, minorities and those treated at MSHs were more likely to experience treatment delays. Interventions addressing barriers to timely breast cancer care at MSHs may be an effective approach to reducing racial/ethnic disparities.

Nearly 60% of all patients diagnosed with breast cancer are 65 years of age or older, and with an aging US population, the burden of breast cancer in older adults will continue to grow.[1] While older women are thought to have more biologically indolent disease than younger women, older women have been found to have worse overall survival as well as breast cancer-specific survival.[2] It has been speculated that the factors contributing to this may include lower treatment intensity, lower treatment adherence, and variable disease biology,[3] but this area remains underexplored as there remains no standardized approach to defining 'appropriate' care in older breast cancer patients.

Meanwhile, treatment disparities by race/ethnicity have been well-documented in breast cancer literature. For example, Black and Hispanic women are less likely to be referred for annual mammography and to receive appropriate therapy than non-Hispanic White women.[4,5] Higher breast cancer mortality in Black women compared with White women is also likely multifactorial, including differences in insurance status, socioeconomic status, comorbidities, tumor characteristics, and epigenetic and environmental factors.[6,7] Older minority patients may thus be especially vulnerable to poorer quality of care.

Although research on racial and ethnic disparities has mostly centered on exploring individual patient characteristics and provider biases, there is a growing body of work examining how site of care can contribute to disparities in care across specialties.[8-11] Studies have long recognized that minority patients tend to be concentrated at select hospitals, with the top quartile of hospitals serving the highest volume of Black patients caring for nearly 90% of all older Black patients.[12] Minority-serving hospitals (MSHs), defined as the top decile of hospitals serving predominantly Black or Hispanic patients, have been shown to be associated with a range of poorer outcomes, such as lower rates of definitive cancer treatment and higher readmission rates,[8,10-12] although some studies have also found mixed results.[13-15]

Time to treatment initiation has been suggested as a measure of quality of cancer care, as delays in surgery and systemic therapy initiation have been shown to be associated with lower overall survival.[16-19] Understanding the potential role of hospital-specific factors in contributing to quality of care can guide future public health interventions meant to aid the older minority population. This study thus sought to examine how racial and ethnic disparities may be associated with the timeliness of treatment initiation in older adults with non-metastatic breast cancer by site of care (MSH vs. non-MSH).

METHODS

Data

The breast cancer participant user file of the National Cancer Database (NCDB), a dataset by the American Cancer Society and the American College of Surgeons, was used to obtain data from 2010 to 2017. This dataset captures approximately 70% of newly diagnosed cancer cases in the US from more than 1500 Commission on Cancer (CoC)-accredited facilities.[20] This study was deemed exempt by the Massachusetts General Brigham Institutional Review Board.

Patients

All women aged 65 years or older and diagnosed between 1 January 2010 and 31 December 2017 with Stage 0–III breast cancer of ductal, lobular, or mixed origin were identified (Fig. 1). Clinical stage was defined according to the 7th Edition of the American Joint Commission on Cancer (AJCC) Staging Manual. We excluded patients with unknown race/ethnicity/clinical stage, metastatic disease, time to treatment > 1 year, or neoadjuvant radiotherapy. We also excluded patients who were treated at hospitals that did not have cases present in the dataset for all study years. Racial/ethnic groups were defined by patients' primary racial affiliation and ethnicity as recorded by the NCDB. Abstraction rules for these categories are guided by the Facility Oncology Registry Data Standards (FORDS), which do not explicitly indicate whether these designations are self-reported or assigned.[21] White and Black patients with unknown Hispanic status were included into non-Hispanic White and Black groups, respectively.

Variables

The outcome of interest was time to treatment from diagnosis, with delay in treatment defined as more than 90 days since diagnosis.[16,17] Initial treatment was further classified as surgery or systemic treatment, with the latter being comprised of either neoadjuvant chemotherapy/immunotherapy or endocrine therapy.

Facilities were defined as MSHs if they fell into the top decile of facilities caring for the highest proportion of Black and Hispanic patients, as per previous work focused on MSHs.[9,10,13]

Patient-level variables included age (65–69 years, 70–74 years, 75–79 years, 80–84 years, 85 years), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic White, Hispanic Black, Native American, Asian/Pacific Islander), insurance status (private, Medicare, Medicaid, uninsured, unknown), income (< \$40,000, \$40,000, unknown), educational level (< 80% high school graduation rate, 80%, unknown), region of patient's home ZIP code (metropolitan, urban, rural, unknown), distance of patient's home ZIP code from the treating facility (< 50 miles, 50–100 miles, 100–150 miles, 150–200 miles, > 200 miles, unknown), and Charlson–Deyo comorbidity index (0, 1, 2, 3). Disease characteristics include histology (ductal or lobar), tumor subtype (human epidermal growth factor receptor 2-positive [HER2+], hormone receptor-positive [HR+]/HER2-negative [HER2–], triple negative, unknown), and clinical stage (0 through 3).

Hospital characteristics included facility type (Community Cancer Program, Comprehensive Community Cancer Program, Academic/Research Program, Integrated Network Cancer Program), annual hospital volume of non-metastatic breast cancer cases (< 150 cases per year [bottom 25%], 151–433 cases per year [25–75%], > 433 cases per year [top 25%]), and percentage of patients with Medicaid (classified as quartiles, with quartile 1 having the lowest percentage of Medicaid patients).

Statistical Analysis

Our primary outcome was risk-adjusted odds of treatment delay. Multivariable logistic regression models were used to examine the relationship between MSH status and odds of treatment delay across racial/ethnic groups after adjusting for patient (age, education, income, insurance, urban/rural status, Charlson–Deyo comorbidity index, distance from facility), tumor (histology, subtype, clinical stage), and hospital characteristics (facility type, volume, percentage of Medicaid patients). Odds ratio (OR) > 1 suggests a greater likelihood of treatment delay compared with the reference group. Chi-square tests of proportion were used to test for statistical significance of differences in baseline characteristics between patients treated at MSHs and non-MSHs. All analyses were performed using Stata, version 14.2 (StataCorp LLC, College Station, TX, USA).

RESULTS

Between 2010 and 2017, we identified 557,816 women ≥ 65 years of age (mean age 73.7 years, standard deviation [SD] 6.7 years) newly diagnosed with stage 0–III breast cancer; 45,294 (8.1%) women were treated across 41 MSHs, compared with 512,522 (91.9%) across 1 46 non-MSHs (Table 1).

The racial distribution of patients by hospital type are shown in Table 1. 32.1% of patients at MSHs were Hispanic and/or Black, compared with 11.2% at non-MSHs. In contrast, non-Hispanic White women made up 64.5% of patients at MSHs, compared with 86.2% at non-MSHs. A higher proportion of minority patients had lower income, lower education levels, higher Charlson–Deyo comorbidity score, Medicaid insurance, and triple-negative histology (electronic supplementary material [ESM]).

Overall, 65.9% of MSHs were academic centers, compared with 16.2% of non-MSHs, while 41.5% of MSHs were high volume versus 3.7% of non-MSHs; 56.1% of MSHs served the highest quartile of Medicaid patients versus only 28.6% of non-MSHs.

The average time to any treatment was 33.71 days (SD 26.92 days), with 39.47 days (SD 31.03 days) at MSHs versus 33.20 days (SD 26.47 days) at non-MSHs ($p < 0.001$) (Table 2). 97.0% of women who underwent treatment received it within 90 days, with 97.5% of non-Hispanic White women and 93.9% of minority women being treated within 90 days. In terms of site of care, 94.8% of patients at MSHs and 97.1% of patients at non-MSHs started treatment within 90 days ($p < 0.001$).

In our multivariable logistic regression model, minority patients consistently had higher odds of treatment delay than non-Hispanic White patients across all types of treatment, even after adjusting for MSH status and other covariates (Fig. 2). Although differences in treatment delay between minority groups were not statistically significant, all had statistically significant higher odds of treatment delay compared with non-Hispanic White women.

Patients treated at MSHs had higher odds (OR 1.28, 95% confidence interval [CI] 1.21–1.36) of treatment delay than patients at non-MSHs, regardless of race/ethnicity. Even

non-Hispanic White patients treated at MSHs were more likely to experience treatment delay than their counterparts at non-MSHs (OR 1.33, 95% CI 1.23–1.43), which was mostly driven by surgery delays (OR 1.35, 95% CI 1.24–1.46). While MSH status did not affect time to treatment for Hispanic Black and Asian/Pacific Islander patients, Hispanic White, non-Hispanic Black, and Native American patients had higher odds of treatment delay if they were treated at MSHs than at non-MSHs (ESM). Notably, Native American patients treated at MSHs had very high odds of treatment delay (OR 5.99, 95% CI 2.92–12.29) when compared with non-Hispanic White patients at non-MSHs. Figure 3 and Table 3 provide a summary of the adjusted analyses.

Older age, higher Charlson–Deyo comorbidity score, Medicaid insurance, lower education level, greater distance from facility, and higher Medicaid quartile were covariates associated with higher odds of treatment delay. Meanwhile, rural region, private or Medicare insurance, and higher clinical stage at diagnosis were associated with lower odds of treatment delay (Table 4).

DISCUSSION

In this large, retrospective, registry-based study of older women diagnosed with non-metastatic breast cancer, the majority of women initiated treatment within 90 days of diagnosis. However, there were significantly higher odds of treatment delay among all minority groups compared with non-Hispanic White women. These disparities were also associated with the facilities at which patients received care: patients treated at MSHs had 28% higher odds of starting breast cancer treatment after 90 days than those at non-MSHs.

Our study is unique in that it compares time to treatment between racial/ethnic groups and hospitals with and without minority-serving status, as well as the intersection of both. We found that, among minorities, not all racial/ethnic groups treated at MSHs had higher odds of treatment delay than their counterparts at non-MSHs.

Our results are consistent with most other retrospective studies that have found longer time to treatment in Black and Hispanic breast cancer patients compared with their non-Hispanic White counterparts,[22] whether initial treatment consisted of surgery [16,23-25] or neoadjuvant chemotherapy.[19]

While our study also noted that Asian/Pacific Islanders and Native Americans had higher odds of treatment delays, time to treatment studies of Asian/Pacific Islander and Native American patients have shown mixed results. Gorin et al.[22] and Chavez-MacGregor et al.[17] did not find higher odds treatment delay among Asian/Pacific Islander patients. Navarro et al. found that Chinese, Asian Indian or Pakistani, and Korean breast cancer patients were more likely to receive surgery within 90 days of diagnosis than non-Hispanic White patients.[24] While Adams et al.[26] found no significant difference in treatment initiation between American Indian/Alaska Native and non-Hispanic White patients (OR 1.00, 95% CI 0.86–1.16), Wilson et al.[27] found that Native American patients had higher odds of surgery delay compared with non-Hispanic White patients (OR 6.3, 95% CI 2.3–17.2).

Multiple factors may contribute to treatment delays, including preoperative magnetic resonance imaging (MRI), plastic surgery consultation, genetic testing results, and additional biopsies necessary for treatment decision making and high-quality care. Existing data suggest that non-Hispanic White women may experience these more time-consuming processes than racial/ethnic minorities. In a study analyzing women without a definitive breast cancer diagnosis, White women were much more likely to undergo breast biopsy than Black or Hispanic women[28]; whether this disparity extends to additional preoperative biopsies after the diagnosis of cancer is unclear. In addition, non-Hispanic White women have been found to be likely to undergo preoperative MRI[29] and breast reconstruction,[27,30] and to receive genetic testing referrals, than minority women.[31] This suggests that minorities may experience even greater disparities in timely care than our findings capture. However, data regarding how these disparities play out, specifically in older adults, are lacking and differential use of these services in older populations (e.g. lower rates of breast reconstruction and genetic testing) likely alter how treatment delays are affected.[32,33]

When time to treatment was compared within racial/ethnic groups by MSH status, non-Hispanic White, Hispanic White, non-Hispanic Black, and Native American patients at MSHs were found to experience higher odds of treatment delay compared with their counterparts at non-MSHs. These findings suggest that Hispanic White, non-Hispanic Black, and Native American patients treated at MSHs were impacted by both their race/ethnicity and site of care. That Native American patients at MSHs had such higher odds of surgery delay compared with not just non-Hispanic White patients but also other minority groups, including Native American patients at non-MSHs, despite low sample size, was striking. This suggests that Native American patients at MSHs are particularly vulnerable to treatment delays.

Meanwhile, Hispanic Black and Asian/Pacific Islander patients experienced no significant difference in care between those treated at MSHs or non-MSHs, suggesting that site of care did not influence the timeliness of treatment in these populations. Lack of significant results in the Hispanic Black population could be due to low sample size. Hispanic and Asian/Pacific Islanders have also been found to have overall lower cancer-specific mortality than non-Hispanic Whites, yet both communities represent marked genetic, cultural, behavioral, and socioeconomic diversity. Progress in this area thus rests on disaggregating racial and ethnic data in oncologic research.[25,34-36]

The policy implications of these findings are significant. Overall, this study adds to existing literature examining how site of care affects health care quality for minority patients. While delays in breast cancer treatment in minority patients could be partly explained by cultural differences and socioeconomic factors not captured with this study's risk-adjusted model, this study also shows that MSHs have inherent inefficiencies that also contribute to treatment delays. Medical organizations, such as the National Consortium of Breast Centers, have included 'timely care' as a quality indicator and the CoC has a quality measure around time to chemotherapy in women under 70 years of age with HR–breast cancer,[37,38] but timeliness of breast cancer treatment has yet to be rigorously defined and incorporated into government quality initiatives. Given that care for minorities in the US is disproportionately high at relatively few hospitals, targeted interventions at these hospitals can help address

racial/ethnic disparities in an effective and efficient manner. However, care must be taken to use appropriate guidelines that consider potentially necessary delays in treatment, such as the need for further imaging work-up and biopsies, patients obtaining second opinions, and time needed to coordinate thorough multidisciplinary care. In this older population, treatment may also be delayed to optimize patients from a medical standpoint (e.g., ensuring patients' comorbidities are controlled to allow them to undergo the physiologic stress of breast cancer treatment).

Limitations

Our study has a number of limitations. First, while representing 70% of new cancer diagnoses in the US, the NCDB is a hospital-based dataset, drawing from CoC-accredited programs.[39] Our findings thus only pertain to patients seen in CoC hospitals and further research is needed to understand patterns of care in non-CoC hospitals. Second, sample sizes for Hispanic Black, Native American, and Asian/Pacific Islander patients were small and thus difficult to assess for statistically significant findings. More granular breakdowns of minority populations are also needed. Third, there is currently no gold standard for time to treatment; worse survival has been observed in patients undergoing surgery > 90 days after diagnosis,[16] initiating adjuvant chemotherapy > 120 days after diagnosis,[17,18] and initiating neoadjuvant chemotherapy > 60 days after diagnosis, but, overall, the optimal timeframe to treatment initiation remains unclear. Fourth, the reasons behind treatment delays cannot be explored in this dataset and there may be patients with very valid reasons for increased time to treatment. Building upon our findings with future research into the specific barriers and facilitators to timely care in MSHs is thus paramount.

CONCLUSIONS

While most older women with non-metastatic breast cancer received timely care at CoC hospitals, this study found that minorities and those treated at MSHs were more likely to experience treatment delays. These effects persisted even after risk-adjusting for possible patient and hospital factors that could explain the results. Future policy interventions focusing on improving quality of care at MSHs may be an efficient approach to reduce racial/ethnic disparities. The reasons for treatment delays likely vary between racial/ethnic groups, and it remains unclear whether patients who suffer delays in time to first treatment received are more likely to suffer delays in adjuvant therapies. Future research needs to explore the drivers behind treatment delays in CoC hospitals as well as the magnitude of treatment delays in non-CoC MSHs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGMENTS

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NCDB breast cases (2010-2017)
N = 1,862,819

Cases of hospital present in dataset for all study years
N = 1,761,642

Age 65+ years
N = 734,291

Exclude clinical stage 4
N = 696,558

Exclude male sex, unknown race or clinical stage
N = 622,289

Exclude tumors with histology other than ductal or lobular (ICD-10 850.x, 852.0-852.5)
N = 568,705

Exclude neaodjuvant radiotherapy or tumor destruction
N = 567,469

Exclude unknown time to treatment or time to treatment > 1 year
N = 557,816
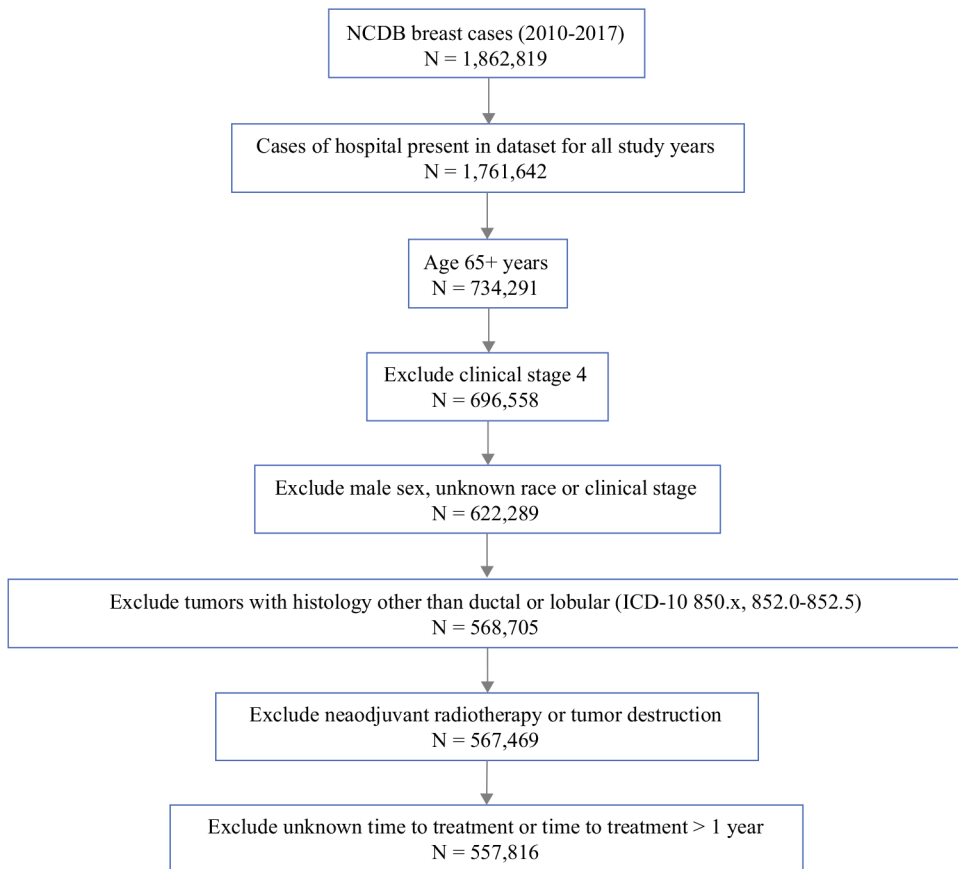
FIG. 1.

Consolidated standards of reporting trials (CONSORT) diagram. *NCDB* national cancer database, *MSH* minority-serving hospital, *ICD-10* international classification of diseases, 10th Revision
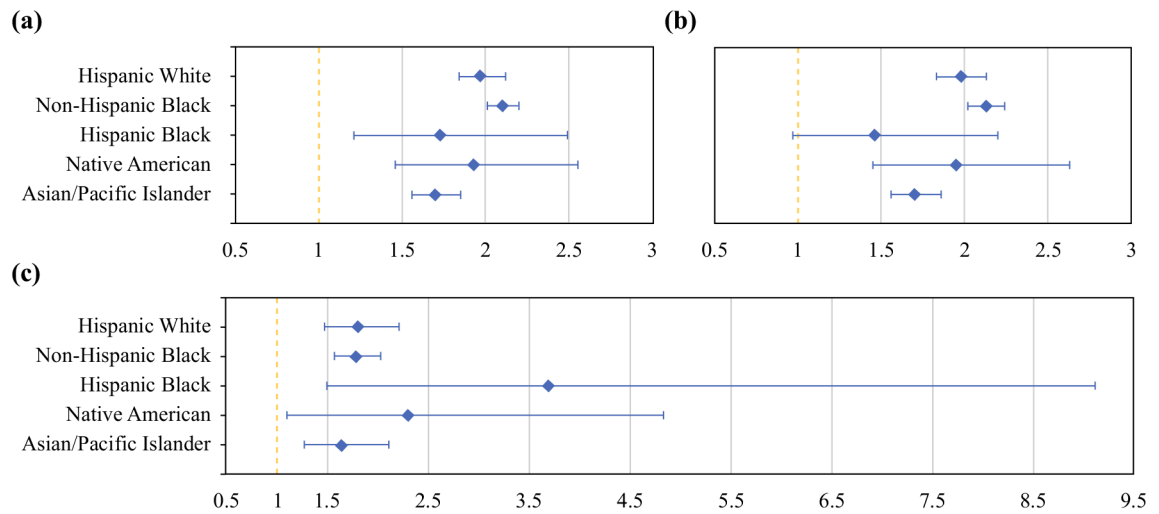
FIG. 2.

Adjusted odds of treatment delay in minority groups compared with non-Hispanic White women (reference group) of (**a**) any treatment delay; **b** surgery delay; and **c** systemic treatment delay
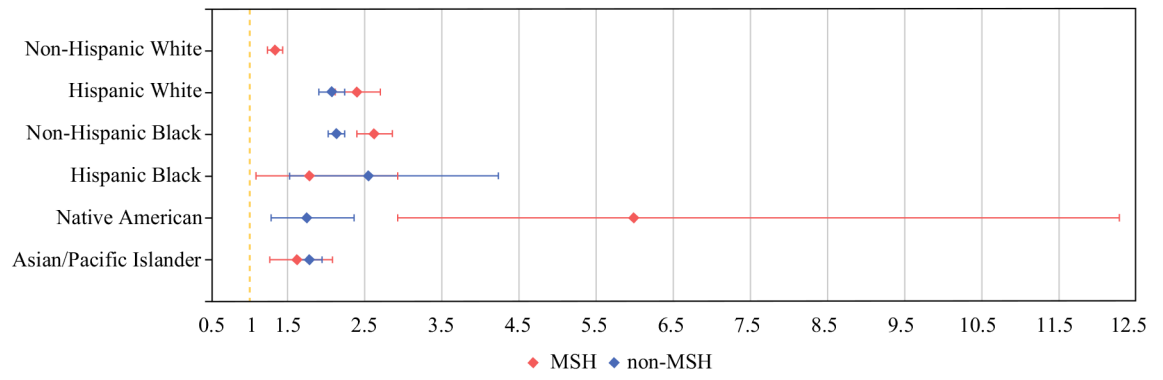
FIG. 3.

Adjusted odds of any treatment delay compared with non-Hispanic White women treated at non-MSHs. *MSH* minority-serving hospital

TABLE 1

Baseline characteristics by site of care

| Characteristic	No. (%) of patients		
	MSH	**Non-MSH**	***p*-Value**
Patient characteristics			
Total patients	45,294 (8.1)	512,522 (91.9)	NA
Age group, years			
65–69	17,474 (38.6)	174,349 (34.0)	< 0.001
70–74	12,374 (27.3)	135,267 (26.4)	
75–79	7929 (17.5)	95,176 (18.6)	
80–84	4423 (9.8)	61,426 (12.0)	
85	3094 (6.8)	46,304 (9.0)	
Race/ethnicity			
Non-Hispanic White	29,228 (64.5)	441,795 (86.2)	< 0.001
Hispanic White	9577 (21.1)	43,520 (8.5)	
Non-Hispanic Black	4685 (10.3)	13,438 (2.6)	
Hispanic Black	257 (0.6)	232 (0.0)	
Native American	62 (0.1)	1181 (0.2)	
Asian/Pacific Islander	1485 (3.3)	12,356 (2.4)	
Year of diagnosis			
2010–2011	8794 (19.4)	110,509 (21.6)	< 0.001
2012–2013	10,828 (23.9)	124,041 (24.2)	
2014–2015	12,385 (27.3)	134,289 (26.2)	
2016–2017	13,287 (29.3)	143,683 (28.0)	
Charlson–Deyo comorbidity index			
0	34,975 (77.2)	394,858 (77.0)	< 0.001
1	7903 (17.4)	86,753 (16.9)	
2	1705 (3.8)	21,706 (4.2)	
3	711 (1.6)	9205 (1.8)	
Insurance			
Uninsured	488 (1.1)	1781 (0.3)	< 0.001

Characteristic	No. (%) of patients		
	MSH	**Non-MSH**	**p-Value**
Medicaid	1017 (2.2)	6489 (1.3)	
Medicare	34,988 (77.2)	431,093 (84.1)	
Private	6669 (14.7)	66,021 (12.9)	
Unknown	2132 (4.7)	7138 (1.4)	
Income, $US			< 0.001
< 40,000	9421 (20.8)	68,332 (13.3)	
40,000	32,548 (71.9)	378,574 (73.9)	
Unknown	3325 (7.3)	65,616 (12.8)	
Education level, % with high school diploma			< 0.001
< 80	11,201 (24.7)	70,879 (13.8)	
80	30,811 (68.0)	376,801 (73.5)	
Unknown	3282 (7.3)	64,842 (12.7)	
Region			< 0.001
Metropolitan	40,494 (89.4)	431,052 (84.1)	
Urban	2378 (5.3)	63,576 (12.4)	
Rural	329 (0.7)	8526 (1.7)	
Unknown	2093 (4.6)	9368 (1.8)	
Distance from facility, miles			< 0.001
< 50	37,491 (82.8)	427,387 (83.4)	
50–100	2818 (6.2)	16,472 (3.2)	
100–150	732 (1.6)	3320 (0.6)	
150–200	330 (0.7)	1192 (0.2)	
> 200	1048 (2.3)	3313 (0.6)	
Unknown	2875 (6.3)	60,838 (11.9)	
Disease and treatment characteristics			
Histology			< 0.001
Ductal	36,667 (81.0)	425,979 (83.1)	
Lobular	5551 (12.3)	60,150 (11.7)	
Mixed	3076 (6.8)	26,393 (5.1)	
Tumor subtype			

Characteristic	No. (%) of patients		p-Value
	MSH	Non-MSH	
HER2+	3511 (7.8)	39,346 (7.7)	< 0.001
HR+/HER2−	23,473 (51.8)	268,098 (52.3)	
Triple negative	3269 (7.2)	31,593 (6.2)	
Unknown	15,041 (33.2)	173,485 (33.8)	
Clinical stage at diagnosis			< 0.001
0	8748 (19.3)	89,414 (17.4)	
1	24,084 (53.2)	289,453 (56.5)	
2	10,376 (22.9)	111,284 (21.7)	
3	2086 (4.6)	22,371 (4.4)	
Treatment			
Received treatment	44,524 (98.3)	503,925 (98.3)	0.720
No treatment	7770 (1.7)	8597 (1.7)	
Upfront surgery	39,615 (87.5)	461,617 (90.1)	< 0.001
Upfront systemic treatment	4803 (10.6)	37,733 (7.4)	
Upfront chemotherapy/immunotherapy	2450 (5.4)	19,723 (3.8)	< 0.001
Upfront endocrine therapy	2257 (5.0)	21,379 (4.2)	< 0.001
Hospital characteristics			
Number of facilities	41	1146	NA
Facility type, facilities			< 0.001
CCP	0 (0.0)	295 (25.7)	
CCCP	6 (14.6)	480 (41.9)	
Academic	27 (65.9)	186 (16.2)	
INCP	8 (19.5)	185 (16.1)	
Hospital volume, facilities			< 0.001
< 150 cases/year	1 (2.4)	689 (60.1)	
151–433 cases/year	23 (56.1)	415 (36.2)	
> 433 cases/year	17 (41.5)	42 (3.7)	
% Medicaid, facilities			0.002
Quartile 1 (lowest % Medicaid)	5 (12.2)	236 (20.6)	
Quartile 2	7 (17.1)	272 (23.7)	

Characteristic	No. (%) of patients		
	MSH	Non-MSH	*p*-Value
Quartile 3	6 (14.6)	310 (27.1)	
Quartile 4 (highest % Medicaid)	23 (56.1)	328 (28.6)	

MSH minority-serving hospital, *HER2* human epidermal growth factor receptor 2, *HR* hormone receptor, *CCP* Community Cancer Program, *CCCP* Comprehensive Community Center Program, *INCP* Integrated Network Cancer Program, *NA* not available

TABLE 2

Average time to initial treatment by site of care

Time to treatment	Total			MSH			Non-MSH			*p*-Value
	N	Mean (days)	SD	*N*	Mean (days)	SD	*N*	Mean (days)	SD	
Any treatment	548,449	33.71	26.92	44,524	39.47	31.03	503,925	33.20	26.47	<0.001
Surgery	501,232	33.52	26.38	39,615	39.20	30.22	461,617	33.03	25.97	<0.001
Systemic treatment	42,536	36.36	31.83	4803	42.69	36.04	37,733	35.55	31.16	<0.001
Chemotherapy/immunotherapy	22,173	37.96	25.18	2450	42.80	30.50	19,723	37.36	24.38	<0.001
Endocrine therapy	23,642	35.09	36.32	2257	43.14	42.29	21,385	34.24	35.53	<0.001

MSH minority-serving hospital, *SD* standard deviation

TABLE 3

Adjusted odds of surgery and systemic treatment delay compared with non-Hispanic White women treated at non-MSHs

Race/ethnicity	MSH status	Time to surgery			Time to systemic treatment		
		N	Mean (days)	OR (95% CI)	N	Mean (days)	OR (95% CI)
Non-Hispanic White	Non-MSH	400,137	32.35	Reference	31,232	34.24	Reference
	MSH	26,026	36.99	1.35 (1.24–1.46)	2892	38.52	1.25 (1.00–1.55)
Hispanic White	Non-MSH	11,824	39.72	2.07 (1.90–2.25)	1131	42.29	1.83 (1.43–2.33)
	MSH	3991	42.05	2.39 (2.09–2.72)	530	48.83	2.30 (1.65–3.22)
Non-Hispanic Black	Non-MSH	37,392	38.04	2.15 (2.04–2.27)	4334	42.04	1.78 (1.55–2.05)
	MSH	7996	44.63	2.62 (2.37–2.88)	1207	49.73	2.31 (1.82–2.93)
Hispanic Black	Non-MSH	200	39.93	2.23 (1.24–4.02)	22	42.09	3.66 (1.06–12.64)
	MSH	236	42.63	1.49 (0.85–2.62)	15	68.93	4.87 (1.30–18.26)
Native American	Non-MSH	1059	37.47	1.75 (1.26–2.43)	90	39.62	2.11 (0.96–4.64)
	MSH	56	47.96	6.02 (2.81–12.89)	6	79.17	8.65 (0.83–90.16)
Asian/Pacific Islander	Non-MSH	11,005	36.83	1.78 (1.62–1.96)	924	40.64	1.80 (1.38–2.35)
	MSH	1310	40.35	1.68 (1.29–2.18)	153	40.65	1.09 (0.47–2.55)

Model adjusted for patient (age, Charlson–Deyo comorbidity index score, education level, income level, insurance status, home ZIP code distance from facility), tumor (histology, subtype, clinical stage), and hospital (facility type, volume, percentage of Medicaid patients) characteristics

MSH minority-serving hospital, *OR* odds ratio, *CI* confidence interval

TABLE 4

Multivariable analysis of factors associated with odds of treatment delay

Characteristic	OR (95% CI)		
	Any treatment	Upfront surgery	Upfront systemic treatment
Patient characteristics			
Age group, years			
65–69	Reference	Reference	Reference
70–74	0.95 (0.91–0.99)	0.93 (0.89–0.98)	1.16 (1.02–1.31)
75–79	0.99 (0.95–1.04)	0.96 (0.91–1.01)	1.26 (1.10–1.45)
80–84	1.12 (1.06–1.18)	1.10 (1.04–1.16)	1.14 (0.98–1.33)
85	1.32 (1.25–1.40)	1.28 (1.20–1.36)	1.05 (0.92–1.21)
Race/ethnicity			
Non-Hispanic White	Reference	Reference	Reference
Hispanic White	2.00 (1.87–2.14)	2.01 (1.86–2.16)	1.81 (1.48–2.20)
Non-Hispanic Black	2.10 (2.01–2.20)	2.13 (2.03–2.24)	1.78 (1.57–2.02)
Hispanic Black	1.80 (1.26–2.57)	1.53 (1.01–2.30)	3.64 (1.49–8.91)
Native American	1.96 (1.48–2.58)	1.97 (1.46–2.66)	2.33 (1.11–4.88)
Asian/Pacific Islander	1.68 (1.55–1.83)	1.69 (1.55–1.85)	1.59 (1.24–2.05)
Charlson–Deyo comorbidity index			
0	Reference	Reference	Reference
1	1.08 (1.04–1.13)	1.09 (1.04–1.14)	1.09 (0.97–1.23)
2	1.32 (1.23–1.41)	1.34 (1.25–1.45)	1.10 (0.90–1.34)
3	1.57 (1.42–1.72)	1.57 (1.41–1.75)	1.40 (1.11–1.77)
Insurance			
Private	Reference	Reference	Reference
Medicare	0.91 (0.86–0.95)	0.90 (0.85–0.94)	0.95 (0.83–1.10)
Medicaid	1.51 (1.36–1.67)	1.54 (1.38–1.72)	1.35 (1.01–1.81)
Uninsured	1.25 (1.03–1.50)	1.26 (1.02–1.56)	1.13 (0.71–1.80)
Income, $US			
40,000	Reference	Reference	Reference
< 40,000	0.92 (0.88–0.98)	0.91 (0.87–0.97)	0.94 (0.82–1.09)

Characteristic	OR (95% CI)		
	Any treatment	Upfront surgery	Upfront systemic treatment
Education level, % with high school diploma			
80	Reference	Reference	Reference
< 80	1.26 (1.21–1.32)	1.29 (1.22–1.35)	1.16 (1.02–1.33)
Region			
Metropolitan	Reference	Reference	Reference
Urban	0.67 (0.63–0.72)	0.66 (0.62–0.71)	0.77 (0.65–0.91)
Rural	0.66 (0.56–0.77)	0.60 (0.50–0.71)	1.01 (0.69–1.47)
Distance from facility, miles			
< 50	Reference	Reference	Reference
50–100	1.41 (1.28–1.54)	1.40 (1.26–1.54)	1.35 (1.04–1.74)
100–150	1.59 (1.33–1.90)	1.73 (1.44–2.10)	0.72 (0.38–1.37)
150–200	1.47 (1.09–1.99)	1.58 (1.15–2.17)	1.95 (0.38–2.34)
> 200	1.41 (1.13–1.76)	1.44 (1.14–1.84)	1.35 (0.76–2.38)
Disease and treatment characteristics			
Histology			
Ductal	Reference	Reference	Reference
Lobular	1.09 (1.04–1.15)	1.11 (1.04–1.17)	0.95 (0.83–1.09)
Mixed	1.12 (1.05–1.21)	1.14 (1.06–1.23)	0.98 (0.80–1.21)
Tumor subtype			
HER2+	Reference	Reference	Reference
HR+/HER2−	1.03 (0.99–1.07)	1.03 (0.99–1.07)	1.08 (0.98–1.20)
Triple negative	0.90 (0.84–0.97)	0.94 (0.86–1.01)	0.66 (0.55–0.79)
Clinical stage at diagnosis			
0	Reference	Reference	Reference
1	0.64 (0.61–0.66)	0.61 (0.58–0.64)	0.64 (0.53–0.77)
2	0.89 (0.86–0.91)	0.88 (0.86–0.91)	0.61 (0.56–0.67)
3	0.97 (0.95–1.00)	1.02 (0.99–1.05)	0.68 (0.63–0.72)
Hospital characteristics			
MSH status			
Non-MSH	Reference	Reference	Reference

Characteristic	OR (95% CI)		
	Any treatment	Upfront surgery	Upfront systemic treatment
MSH	1.28 (1.21–1.36)	1.29 (1.21–1.37)	1.24 (1.06–1.45)
Facility type			
CCP	Reference	Reference	Reference
CCCP	0.99 (0.93, 1.06)	1.03 (0.96, 1.11)	0.82 (0.68, 0.98)
Academic	1.18 (1.09, 1.27)	1.23 (1.13, 1.33)	0.91 (0.75, 1.12)
INCP	1.13 (1.04, 1.22)	1.20 (1.10, 1.30)	0.82 (0.66, 1.00)
Hospital volume			
> 433 cases/year	Reference	Reference	Reference
151–433 cases/year	1.06 (1.01–1.11)	1.08 (1.03–1.14)	0.96 (0.83–1.09)
< 150 cases/year	1.01 (0.95–1.07)	1.01 (0.94–1.07)	1.01 (0.86–1.20)
% Medicaid, facilities			
Quartile 1 (lowest % Medicaid)	Reference	Reference	Reference
Quartile 2	0.96 (0.92–1.01)	0.94 (0.89–0.99)	1.11 (0.97–1.27)
Quartile 3	1.06 (1.01–1.11)	1.05 (0.99–1.10)	1.14 (0.99–1.31)
Quartile 4 (highest % Medicaid)	1.27 (1.21–1.33)	1.27 (1.21–1.34)	1.17 (1.01–1.34)
Constant	0.03 (0.03–0.03)	0.03 (0.02–0.03)	0.10 (0.07–0.13)

HER2 human epidermal growth factor receptor 2, *HR* hormone receptor, *MSH* minority-serving hospital, *CCP* Community Cancer Program, *CCCP* Comprehensive Community Center Program, *INCP* Integrated Network Cancer Program, *OR* odds ratio, *CI* confidence interval