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Predictors of Nodal Pathologic Complete Response After Neoadjuvant Chemotherapy in Breast Cancer

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Abstract

Introduction: Nodal pathologic complete response (npCR) after neoadjuvant treatment in patients with node-positive breast cancer (BC) avoids the morbidity of axillary dissection. In this study, we aimed to identify predictors of npCR.

Methods: Adult women with stage 2–3 BC and clinically positive nodes from 2011–2021 in the National Cancer Database who received neoadjuvant chemotherapy followed by surgery within 8 months were included. Predictors of npCR were modeled with multivariable logistic regression.

Results: 47,483 patients were included: 18,978 (40.0%) with npCR and 28,505 (60.0%) with nodal residual disease (nRD). Median age for npCR group was 53 (interquartile range [IQR] 21–90) compared to 54 (IQR 21–90, $p < 0.001$) in the nRD group. Triple negative breast cancer (TNBC) was the most common subtype (53.5%) in the npCR group while ER+/HER2– was the most common (46.5%) in the nRD group, $p < 0.001$. After adjusting for sociodemographic factors, comorbidities, tumor characteristics, and treatment, younger age (odds ratio [OR] 0.99, 95% confidence interval [CI] 0.99–0.99), ER–/HER2+ compared to TNBC (OR 1.32, 95% CI 1.21–1.44), and receipt of immunotherapy (OR 1.60, 95% CI 1.46–1.74) were associated with npCR. Black patients were less likely to have npCR overall (OR 0.90, 95% CI 0.85–0.95) and with TNBC and HER2+ tumors, but more likely in ER+/HER2– tumors.

Conclusion: Both tumor and sociodemographic factors were associated with npCR in BC patients. Black compared to white patients were more likely to have npCR in ER+/HER2– subtype

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but less likely in hormone receptor-negative and HER2+ subtypes. Mechanisms underlying these differences should be further investigated.

Keywords

neoadjuvant; nodal; pathologic complete response; axilla; breast cancer

Introduction

In locally advanced breast cancer (BC), neoadjuvant chemotherapy therapy (NCT) has become the preferred treatment, with increasing use in recent years. NCT can reduce tumor size, which increases eligibility for breast conserving therapy (BCT) and provides important information about tumor biology.^{1,2} Patients who achieve total eradication of disease, or pathologic complete response (pCR), have improved survival compared to patients with residual disease (RD), who have increased risk of locoregional and distant recurrence. Additionally, for HER2-positive and TNBC patients, response to NCT identifies the sub-population who would benefit from escalated adjuvant therapy strategies.^{3,4}

For patients with clinically lymph node positive disease, achieving nodal pathologic complete response (npCR) versus having nodal residual disease (nRD) after NCT provides important prognostic information, as the Residual Cancer Burden (RCB) incorporates residual nodal disease in predicting outcomes.^{5,6} Furthermore, npCR may provide more precise prognostic information as it appeared to have a stronger association with survival than in-breast pCR alone.⁷ Beyond prognostication, npCR can also reduce the need for axillary lymph node dissection (ALND), helping to avoid associated morbidity.⁸

Nodal pathologic complete response after neoadjuvant therapy is known to differ by BC subtype.^{9,10} A recent systematic review found that HER2-positive tumors, followed by triple-negative tumors, were more likely to achieve axillary pCR.⁷ However, there is currently a gap in the literature in understanding clinical features that may be associated with nodal response to neoadjuvant therapy by subtype. Given the importance of pCR, identifying characteristics associated with nodal pCR can risk stratify patients who may be over-treated with ALND. Patients unlikely to clear nodal disease are also an important group for whom improved systemic strategies are needed. Therefore, in this study, we aimed to identify factors associated with nodal pCR after NCT by BC subtype.

Methods

Study Population

This study was based on the National Cancer Database (NCDB). Adult women diagnosed between 2011–2021 with clinically node positive BC, including inflammatory, and no metastatic disease were included. Information in the NCDB is reported by participating institutions, and clinically positive nodes are defined for each patient by the reporting institution based on the American Joint Committee on Cancer (AJCC) cancer staging guidelines. Additional inclusion criteria were receipt of neoadjuvant chemotherapy followed by surgery within 8 months of diagnosis. Primary outcome of interest was npCR, defined

as post-NCT eradication of nodal disease, which was compared between four BC subtypes: triple negative breast cancer (TNBC), ER+/HER2+, ER+/HER2-, and ER-/HER2+. Follow up continued for 10 years after diagnosis.

Analysis

Descriptive analyses were used to report patient, clinical, and treatment characteristics for the four groups. Continuous variables were reported as median and interquartile ranges (IQRs), and categorical variables were reported as numbers and percentages. We then examined nodal response to NCT by comparing pre- and post-treatment nodal status. Upstage was defined as post-treatment higher nodal stage, and downstage was defined as post-treatment lower nodal stage. Sociodemographic information, cancer care facility characteristics, clinical characteristics, and treatment regimen were compared between npCR and nRD groups using Chi-squared tests for categorical variables and Kruskal-Wallis test for ordinal variables. Factors associated with npCR were modeled with logistic regression, adjusting for sociodemographic factors (age, race, comorbidities as measured by the Charlson Comorbidity Index, area of residence, insurance type), cancer care facility characteristics (type of cancer care facility), clinical characteristics (clinical T stage, clinical N stage, histology, grade), and treatment regimen (receipt of endocrine therapy, receipt of immunotherapy). Results were reported as odds ratios (ORs) and 95% confidence intervals (CIs). We then performed the same adjusted logistic regression for each BC subtype. In addition, we also stratified the logistic regression by stage and HER2 status, adjusting for receipt of immunotherapy in the HER2+ group.

All analyses were performed with Stata 19.0 (College Station, Texas). The University of North Carolina Institutional Review Board approved this study.

Results

Patient and Treatment Characteristics

A total of 47,483 patients were included: 18,978 (40.0%) had npCR and 28,505 (60.0%) had nRD (Table 1). The median age for the overall cohort was 54 (IQR 21–90). The nRD group was slightly older at median age of 54 (IQR 21–90) compared to 53 (IQR 21–90) in the npCR group, $p < 0.001$. Overall, 3.3% of the whole cohort and of the npCR and nRD groups individually were not insured. In total, 32.5% of the overall cohort received their treatment at an academic program (33.7% of the npCR group and 31.7% of the nRD group, $p = 0.012$). A majority of the overall cohort (86.2%) and of each group (87.0% of the npCR group and 85.7% of the nRD group, $p < 0.001$) had a Charlson comorbidity index of 0. TNBC was the most common BC subtype overall (44.1%) and in the npCR group (53.5%), while ER+/HER2- subtype was the most common in the nRD group (46.5%, $p < 0.001$). A majority of the overall cohort (51.9%) were clinical stage 3. In the npCR group, 52.7% of patients was clinical stage 3, while 51.3% of patients in nRD group were clinical stage 3. About two-thirds of the overall cohort had total mastectomy, though the nRD group had a higher proportion (70.7% compared to 61.2% in the npCR group, $p < 0.001$). In terms of lymph node surgery, 27.9% of the overall cohort received upfront sentinel lymph node biopsy (SLNB) prior to chemotherapy, 50.5% received upfront axillary lymph node dissection (ALND), and

21.6% received SLNB and ALND. Of the npCR group, 41.8% received upfront SLNB, 42.3% received ALND, and 15.9% received SLNB and ALND. Of the nRD group, 18.4% received upfront SLNB, 56.0% received upfront ALND, and 25.6% received SLNB and ALND. In addition, 76.1% of the total cohort (73.3% of npCR patients and 77.9% of nRD patients, $p < 0.001$) received adjuvant radiotherapy.

Nodal Response to Neoadjuvant Therapy

After neoadjuvant therapy, 11,410 (24.0%) had pCR, while 18,978 (40.0%) of the overall cohort had npCR. By each BC subtype, 48.5% of TNBC, 43.6% of ER+/HER2+, 19.4% of ER+/HER2-, and 60.5% of ER-/HER2+ ($p < 0.001$) had npCR. By clinical nodal stage at diagnosis, 24.1% of cN1, 23.4% of cN2, and 26.3% of cN3 had npCR ($p < 0.001$). The most frequent pathologic nodal staging among patients with hormone receptor-negative tumors, regardless of HER2 status, was ypN0 (in TNBC patients: 51.8% of cN1, 41.8% of cN2, and 46.2% of cN3; in ER-/HER2+ patients: 66.2% of cN1, 57.1% of cN2, and 59.3% of cN3) (Figure 1A and 1D). This treatment effect was most pronounced in the ER-/HER2+ cohort (Figure 1D). Similarly, in the ER+/HER2+ cohort, a large proportion of patients had ypN0 (48.0% of cN1, 49.8% of cN2, and 46.0% of cN3) or nodal downstaging (Figure 1B). In comparison, nodal response in the ER+/HER2- group was more heterogeneous, with a large proportion of patients staying the same nodal stage or experiencing nodal upstaging after neoadjuvant therapy (Figure 1C).

Factors Associated with Nodal Pathologic Complete Response

With adjusted logistic regression in the entire cohort, the older the patient, the lower the odds of attaining npCR (OR 0.99, 95% CI 0.99–0.99) [Table 2]. ER-/HER2+ compared to TNBC (OR 1.32, 95% CI 1.21–1.44), receipt of immunotherapy (OR 1.60, 95% CI 1.46–1.74), and higher grades (grade 2 versus 1: OR 1.45, 95% CI 1.21–1.72; grade 3 versus 1: OR 2.32, 95% CI 1.95–2.76) had higher odds of having npCR. Black versus white patients (OR 0.90, 95% CI 0.85–0.95), community versus academic cancer care program (0.91, 95% CI 0.86–0.96), having more than one comorbidity compared to none (OR 0.85, 95% CI 0.74–0.96), ER+/HER2- versus TNBC (OR 0.41, 95% CI 0.38–0.44), receipt of endocrine therapy (OR 0.74, 95% CI 0.68–0.81), higher nodal stage (cN2 compared to cN1: OR 0.76, 95% CI 0.71–0.82; cN3 compared to cN1: OR 0.79, 95% CI 0.73–0.87), lobular compared to ductal histology (OR 0.62, 95% CI 0.54–0.73), and receipt of endocrine therapy (OR 0.89, 95% CI 0.81–0.99) were less likely to be associated with npCR. Stratifying by clinical nodal stage, comparing cN1 with cN2 and cN3 cohorts, one significant change was identified: on adjusted logistic regression, ER+/HER2+ tumors were associated with lower odds of npCR in cN1 but higher odds of npCR in cN2 and cN3 groups (Supplemental Table 1).

Stratifying by BC subtype, adjusted logistic regression also showed that Black compared to white patients with TNBC (OR 0.85, 95% CI 0.79–0.92) and with HER2+ tumors (ER+/HER2+: OR 0.75, 95% CI 0.58–0.97; ER-/HER2+: OR 0.75, 95% CI 0.65–0.86) were less likely to have npCR (Figure 2). In comparison, in patients with ER+/HER2- disease, Black compared to white patients were more likely to have npCR after NCT (OR 1.13, 95%

CI 1.00–1.27), though this was not statistically significant. Further stratification by clinical stage yielded similar results (Supplemental Table 2).

After stratifying by HER2+ status and additionally adjusting for receipt of immunotherapy, Black compared to white patients with HER2+ tumors (OR 0.75, 95% CI 0.66–0.85) were less likely to have npCR (Figure 3). This effect was not seen in the HER2– cohort.

10-Year Overall Survival

Among patients with npCR, 10-year overall survival was excellent and similar among all BC subtypes (Figure 4).

Discussion

Identifying factors associated with nodal pathologic complete response in clinically node-positive breast cancer patients can help personalize treatment strategies, reduce risks of chemotherapy toxicity, and decrease axillary lymph node dissection morbidity. In this study, we found that overall, younger age, ER–/HER2+ tumors, receipt of immunotherapy, and higher grades were associated with higher likelihood of npCR. This study also identified several differences in npCR rates based on race: Black compared to white patients were less likely to have npCR in TNBC and HER2+ groups but more likely to have npCR in the ER+/HER2– group.

In this study, the overall npCR rate of 40.0% is in line with the range of 35%–50% previously reported in the literature.^{11–13} Patients with TNBC (48.5%) and HER2+ (43.6% in ER+/HER2+, 60.5% in ER–/HER2+) subtypes had higher rates of npCR compared to patients with ER+/HER2– disease, which is consistent with previous reports.¹⁰ While pCR has been strongly associated with long-term outcomes and the association between BC subtype and different treatment response rates is well-known, the association of npCR with long-term outcomes is less clear.^{7,14} A large single-institution study found that npCR compared to in-breast only pCR was a stronger predictor of improved overall survival.⁷ An NCBDB review, however, found that the effect of npCR on overall survival differed by BC subtypes, with TNBC and ER+/HER2– tumors having improved survival.¹⁵

These findings highlight that tumor biology may be driving the different response rates to NCT. In this study, younger age and higher grade were both associated with higher npCR rates. Prior studies also showed that younger patients with node-positive ER+/HER2– tumors were found to have higher rates of npCR.¹⁶ Interestingly, this finding correlated with recurrence risk as measured by Oncotype Dx or MammaPrint, with the highest npCR rates among younger patients who had higher recurrence score. In addition, the link between nodal pCR and mortality appears heterogeneous in different patient populations: one study based on the NCBDB found that for patients with nodal pCR, overall survival differed amongst different receptor types, which was identified in this study as well.¹⁵

We found a divergent interaction of race and npCR by BC subtype: Black patients with ER+/HER2– BC were more likely to have npCR compared to white patients, while less likely to have npCR amongst TNBC and HER2+ subtypes. These findings in part are in line with a

previous study that showed rates of achieving pCR overall were lower in Black versus white patients, but contrasts with another study that identified Black patients with HER2+ tumors as having higher overall rates of pCR compared to other racial and ethnic groups.^{14,17} In addition, Telonis et al. demonstrated that no significant differences in pCR were found in the HR+/HER2- subtype by race, but the authors noted that a majority (74.3%) of Black patients had luminal B-like tumors, and that patients with luminal B-like disease were more likely to have pCR than patients with luminal A-like disease.¹⁸ This reflects similar findings reported in a North Carolina population-based study, where basal-like and Luminal-B PAM50 subtypes were more pronounced among Black compared to white patients.¹⁹ These findings suggest that Black compared to white patient populations may be enriched for the basal subtype, which is more likely to respond to chemotherapy.^{18,20,21} Indeed, the distinct tumor biology within receptor subtype by race may also partially contribute to the persistence of lower odds of having npCR for Black compared to white patients with HER2+ tumors after the administration of immunotherapy.

While tumor biology may drive some of the nodal response to NCT, the racial and ethnic differences seen in npCR rates also point to social determinants of health. Black patients have previously been shown to have higher rates of delays in treatment as well as lower rates of chemotherapy completion.^{22,23} Barriers to accessing care and completion of guideline-concordant care may partially mediate the relationship between race and the differences in npCR rates among different BC subtypes. The challenges in achieving completion of recommended therapy may be multifactorial: women from underserved communities have reported barriers related to knowledge, logistics, and social relations.²⁴ In addition, Black women have reported higher symptom burden resulting from systemic therapy, which have been associated with discontinuation of therapy.^{25,26} In this study, however, we were unable to assess the impact of social determinants of health on npCR rates due lack of information on specific treatment utilization patterns among different racial groups.

Axillary management after NCT continues to be an evolving area, with an increasing emphasis on de-escalation of surgery. In terms of surgical treatment, SLNB and targeted axillary dissection after NCT have been two strategies under investigation.²⁷⁻²⁹ In this context, the ability to distinguish chemotherapy-responsive patients who are likely to have npCR may help improve performance characteristics of de-escalated nodal staging approaches, and will be key in identifying the group of patients who can safely avoid ALND. At the same time, the roles of chemotherapy and radiotherapy among specific sub-populations continue to undergo further refinement.^{30,31}

This study has several limitations. The NCDB is reliant on self-reported chart review data from multiple institutions on a voluntary basis, and information in this database is subject to selection bias as well heterogeneity of data extraction methods. In addition, NCDB does not include information regarding recurrence risk, which would have contributed to decisions about administration of NCT in some patients and thus resulted in under-estimation of the true npCR rate. In particular, NCBD has limited data regarding systemic therapy, including but not limited to the type of therapy received, type of HER2+ targeted therapy, dose reductions, dose interruptions, and discontinuations, which are all factors that can influence pCR. Lastly, NCDB includes data from accredited Commission on Cancer (CoC)-accredited

facilities and may not have captured important information about type of care provided to and barriers to care experienced by patients outside of these facilities. More broadly, race is a social construct and a self-reported characteristic. Therefore, the difference in npCR rates observed in this study among different BC subtypes and racial groups warrants further investigation.

Conclusion

Nodal pathologic complete response in breast cancer differed by tumor subtype as well as sociodemographic factors, with ER–/HER2+ subtypes more likely while ER+ subtypes were less likely to have npCR. Black and white patients had divergent nodal response to neoadjuvant therapy: Black patients were more likely to have nodal residual disease with hormone receptor-negative subtypes and HER2+ disease, but more likely to have npCR in ER+/HER2– subtype. The mechanisms underlying these differences are likely multifactorial and should be further investigated.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Synopsis

In node-positive breast cancer, nodal pathologic complete response (npCR) after neoadjuvant chemotherapy is associated with tumor and sociodemographic characteristics. Black patients with ER+/HER2- tumors were more likely while those with ER- and HER2+ subtypes were less likely to have npCR.

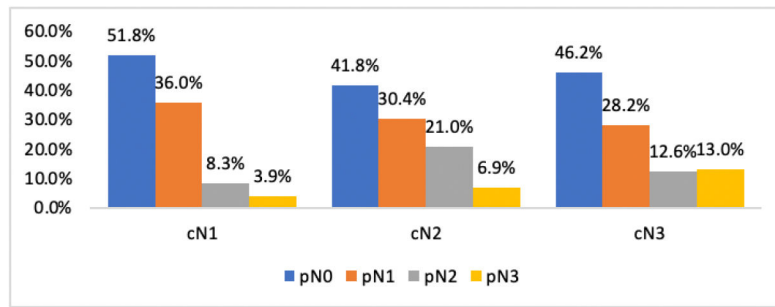
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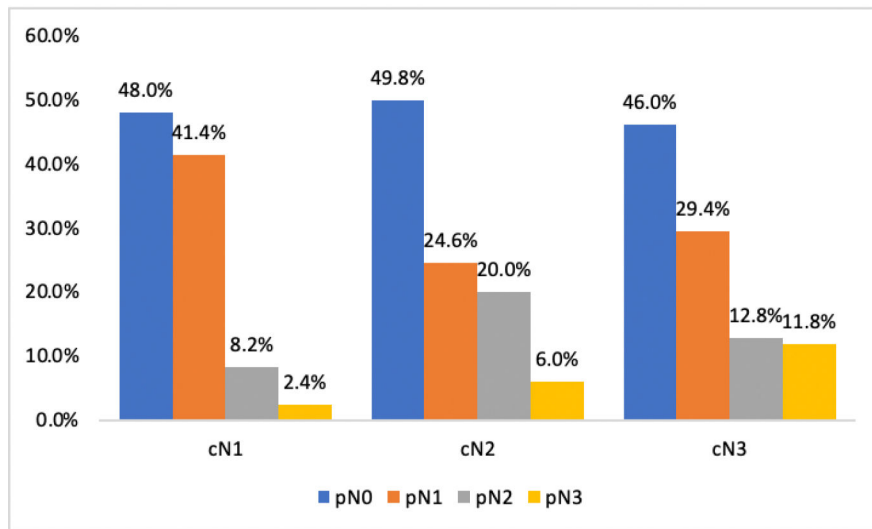
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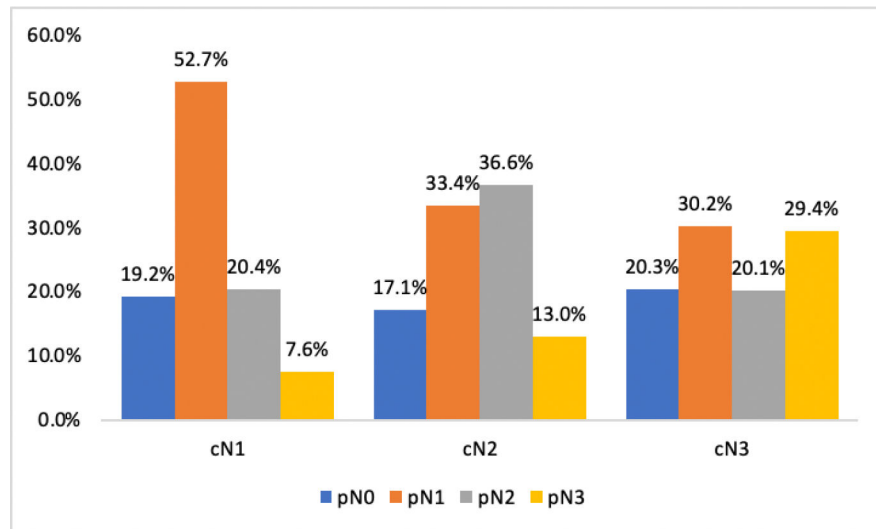
a. TNBC



b. ER+/HER2+



c. ER+/HER2-



d. ER-/HER2+

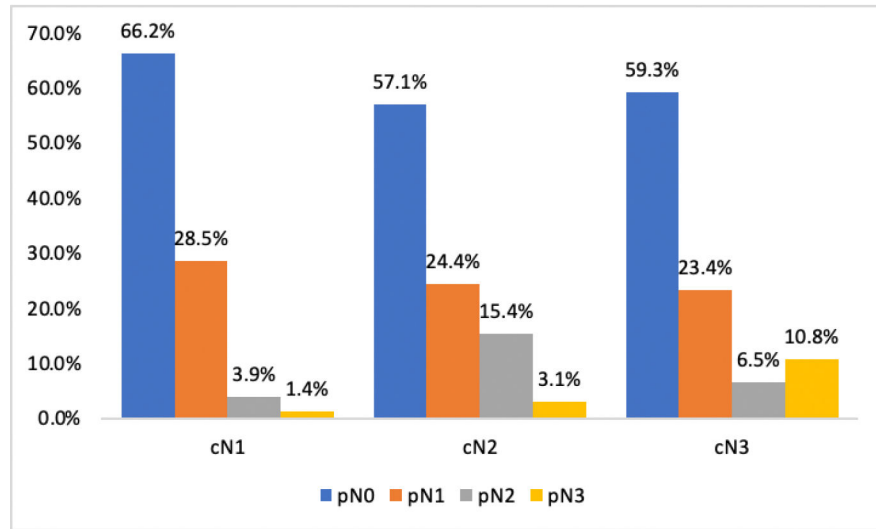


Figure 1. Pathologic response of nodal basin for patients clinically node positive breast cancer undergoing neoadjuvant chemotherapy, by subtype of breast cancer

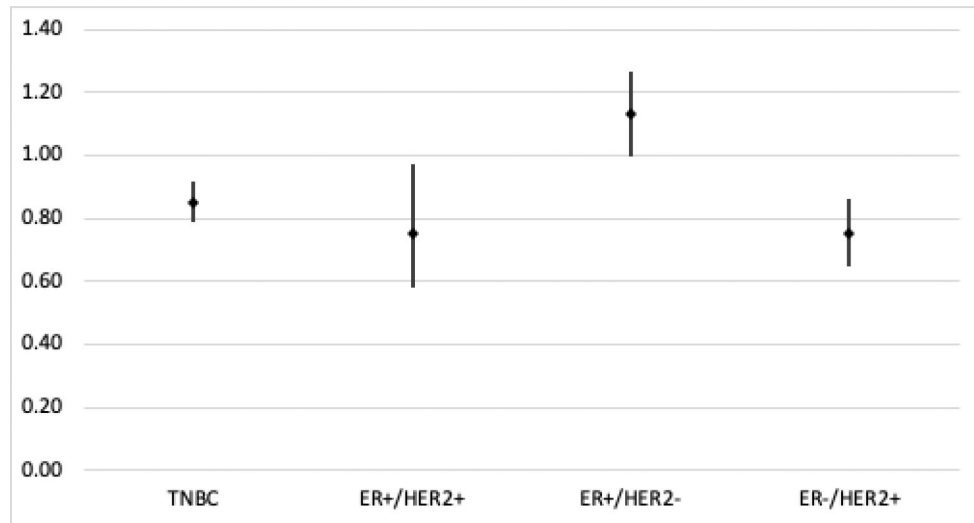


Figure 2. Adjusted^a logistic regression model of association between race and nodal pathologic complete response among patients with clinically node positive breast cancer after neoadjuvant chemotherapy, stratified by breast cancer subtype

^a Adjusted for age, place of residence, insurance, cancer care facility type, Charlson Comorbidity Index, histology, grade, receipt of endocrine therapy for hormone receptor-positive subtypes, and receipt of immunotherapy for HER2+ subtypes

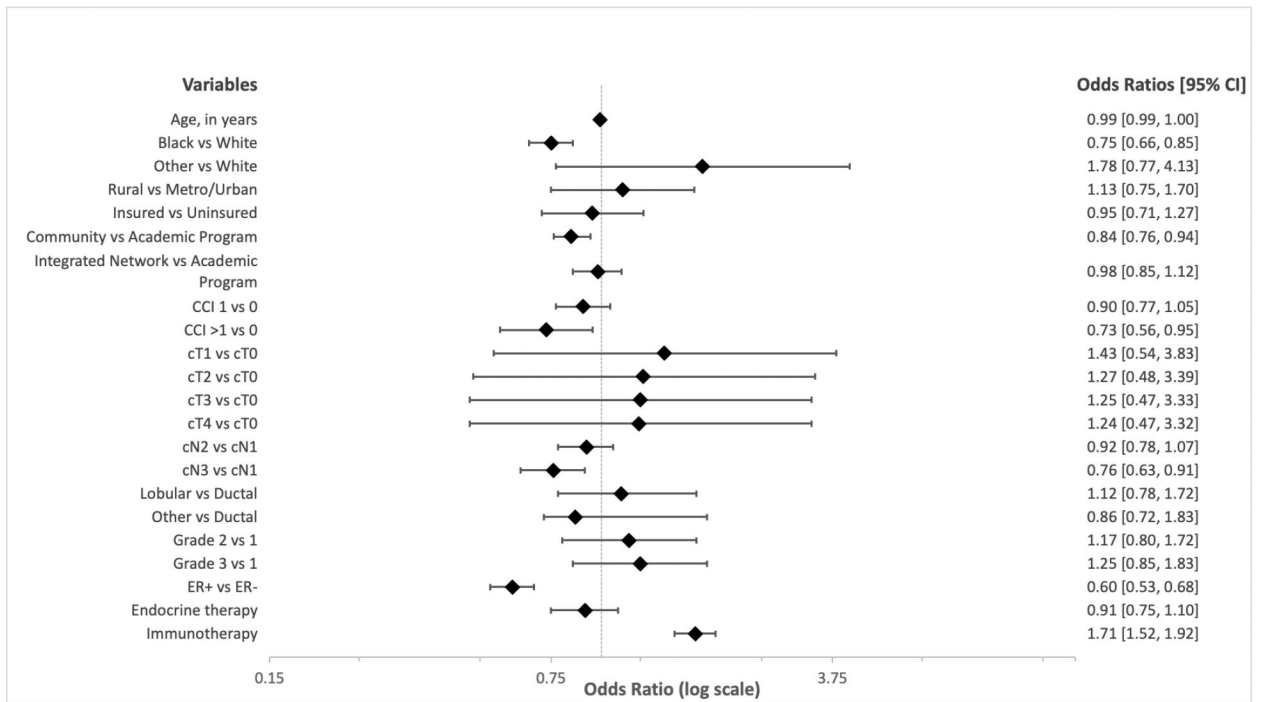
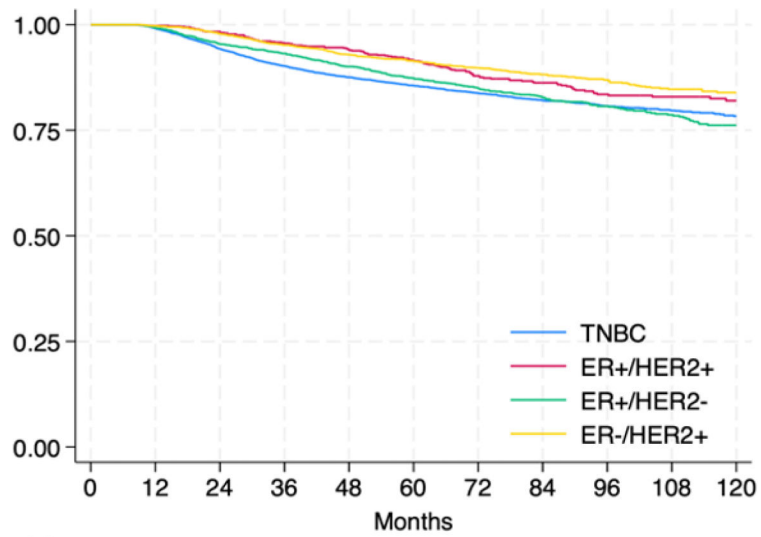


Figure 3. Forest plot of adjusted logistic regression models of factors associated with nodal pathologic complete response among patients with clinically node positive HER2+ breast cancer after neoadjuvant chemotherapy and with immunotherapy



| Number at risk | | 0 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 |
|----------------|------|------|------|------|------|------|------|------|------|-----|-----|-----|
| TNBC | 5915 | 5838 | 5455 | 5084 | 4677 | 4034 | 3109 | 2275 | 1571 | 991 | 511 | |
| ER+/HER2+ | 862 | 856 | 825 | 781 | 737 | 650 | 526 | 423 | 320 | 236 | 144 | |
| ER+/HER2- | 1885 | 1857 | 1758 | 1673 | 1555 | 1347 | 1062 | 791 | 572 | 360 | 179 | |
| ER-/HER2+ | 2786 | 2762 | 2656 | 2504 | 2333 | 2029 | 1581 | 1152 | 751 | 453 | 234 | |

Figure 4. 10-year overall survival among patients with clinically node positive breast cancer and nodal pathologic complete response after neoadjuvant chemotherapy, by breast cancer subtype

Table 1.
Demographic and clinical characteristics of patients with clinically node positive breast cancer after neoadjuvant chemotherapy, by pathologic nodal response

| Characteristics | Overall Cohort (n=47,483) | Nodal Pathologic Complete Response (n=18,978) | Nodal Residual Disease (n=28,505) | P value |
|--|---------------------------|---|-----------------------------------|------------------|
| Age (median, interquartile range, years) | 54 (21–90) | 53 (21–90) | 54 (21–90) | <0.001 |
| Race, no (%) | | | | |
| White | 34,132 (77.3%) | 13,550 (77.0%) | 20,582 (77.5%) | |
| Black | 9,845 (22.3%) | 3,977 (22.6%) | 5,868 (22.1%) | |
| Other | 199 (0.5%) | 82 (0.5%) | 117 (0.4%) | 0.20 |
| Place of residence, no (%) | | | | |
| Metro/Urban | 46,830 (98.6%) | 18,723 (98.7%) | 28,107 (98.6%) | |
| Rural | 653 (1.4%) | 255 (1.3%) | 398 (1.4%) | 0.50 |
| Insurance status, no (%) | | | | |
| Not insured | 1,560 (3.3%) | 624 (3.3%) | 936 (3.3%) | |
| Insured | 45,923 (96.7%) | 18,354 (96.7%) | 27,569 (96.7%) | 1.0 |
| Treatment facility region, no (%) | | | | |
| South | 17,461 (42.8%) | 6,774 (42.5%) | 10,687 (43.1%) | |
| Northeast | 7,117 (17.5%) | 2,740 (17.2%) | 4,377 (17.6%) | |
| Midwest | 9,782 (24.0%) | 3,878 (24.3%) | 5,904 (23.8%) | |
| West | 6,404 (15.7%) | 2,548 (16.0%) | 3,856 (15.5%) | 0.10 |
| Facility type, no (%) | | | | |
| Academic/Research Program | 13,239 (32.5%) | 5,375 (33.7%) | 7,864 (31.7%) | |
| Community Programs | 18,391 (45.1%) | 6,962 (43.7%) | 11,429 (46.0%) | |
| Integrated Network Cancer Program | 9,134 (22.4%) | 3,603 (22.6%) | 5,531 (22.3%) | 0.012 |
| CCI ^a , no (%) | | | | |
| 0 | 40,943 (86.2%) | 16,504 (87.0%) | 24,439 (85.7%) | |
| 1 | 5,093 (10.7%) | 1,962 (10.3%) | 3,131 (11.0%) | |
| >1 | 1,447 (3.1%) | 512 (2.7%) | 935 (3.3%) | <0.001 |
| Subtype | | | | |
| TNBC ^b | 20,929 (44.1%) | 10,144 (53.5%) | 10,785 (37.8%) | |
| ER+/HER2+ | 2,805 (5.9%) | 1,222 (6.4%) | 1,583 (5.6%) | |
| ER+/HER2– | 16,421 (34.6%) | 3,179 (16.8%) | 13,242 (46.5%) | |
| ER–/HER2+ | 7,328 (15.4%) | 4,433 (23.4%) | 2,895 (10.2%) | <0.001 |
| Clinical Stage, no (%) | | | | |
| Stage 2 | 22,852 (48.1%) | 8,972 (47.3%) | 13,880 (48.7%) | |
| Stage 3 | 24,631 (51.9%) | 10,006 (52.7%) | 14,625 (51.3%) | 0.003 |

| Characteristics | Overall Cohort (n=47,483) | Nodal Pathologic Complete Response (n=18,978) | Nodal Residual Disease (n=28,505) | P value |
|----------------------------|---------------------------|---|-----------------------------------|------------------|
| Histology, no (%) | | | | |
| Ductal | 41,076 (86.5%) | 17,259 (90.9%) | 23,817 (83.6%) | |
| Lobular | 1,937 (4.1%) | 302 (1.6%) | 1,635 (5.7%) | |
| Other | 4,470 (9.4%) | 1,417 (7.5%) | 3,053 (10.7%) | <0.001 |
| Grade, no (%) | | | | |
| Well differentiated | 1,391 (3.2%) | 217 (1.3%) | 1,174 (4.5%) | |
| Moderately differentiated | 12,015 (27.6%) | 3,156 (18.1%) | 8,859 (33.9%) | |
| Poorly differentiated | 30,163 (69.2%) | 14,040 (80.6%) | 16,123 (61.6%) | <0.001 |
| Type of surgery, no (%) | | | | |
| None | 77 (0.2%) | 14 (0.1%) | 63 (0.2%) | |
| Partial mastectomy | 15,626 (32.9%) | 7,351 (38.8%) | 8,275 (29.1%) | |
| Total mastectomy | 31,730 (66.9%) | 11,602 (61.2%) | 20,128 (70.7%) | <0.001 |
| Lymph node surgery, no (%) | | | | |
| SLNB ^c only | 12,424 (27.9%) | 7,551 (41.8%) | 4,873 (18.4%) | |
| ALND ^d only | 22,467 (50.5%) | 7,642 (42.3%) | 14,825 (56.0%) | |
| SLNB and ALND | 9,632 (21.6%) | 2,862 (15.9%) | 6,770 (25.6%) | <0.001 |
| Radiation therapy, no (%) | | | | |
| No | 9,692 (20.4%) | 4,458 (23.5%) | 5,234 (18.4%) | |
| Yes | 36,120 (76.1%) | 13,916 (73.3%) | 22,204 (77.9%) | |
| Unknown | 1,671 (3.5%) | 604 (3.2%) | 1,067 (3.7%) | <0.001 |

^aCharlson Cormorbidity Index

^bTriple negative breast cancer

^bSentinel lymph node biopsy

^cAxillary lymph node dissection

Table 2.

Adjusted logistic regression model of factors associated with nodal pathologic complete response among patients with clinically node positive breast cancer after neoadjuvant chemotherapy

| | OR ^a | 95% CI ^b | p-value |
|--|-----------------|---------------------|--------------|
| Age | 0.99 | [0.99 – 0.99] | <0.001 |
| Race (ref: white) | | | |
| Black | 0.90 | [0.85 – 0.95] | <0.001 |
| Other | 1.16 | [0.82 – 1.65] | 0.41 |
| Place of residence (ref: metro/urban) | | | |
| Rural | 1.11 | [0.92 – 1.34] | 0.29 |
| Insurance status (ref: not insured) | | | |
| Insured | 1.03 | [0.90 – 1.18] | 0.68 |
| Facility type (ref: academic/research) | | | |
| Community Programs | 0.91 | [0.86 – 0.96] | <0.001 |
| Integrated Network Cancer Program | 0.97 | [0.91 – 1.03] | 0.30 |
| CCI ^c (ref: 0) | | | |
| 1 | 0.96 | [0.89 – 1.03] | 0.22 |
| >1 | 0.85 | [0.74 – 0.96] | 0.012 |
| Subtype of breast cancer (ref: TNBC ^c) | | | |
| ER+/HER2+ | 0.91 | [0.81 – 1.01] | 0.08 |
| ER+/HER2– | 0.41 | [0.38 – 0.44] | <0.001 |
| ER–/HER2+ | 1.32 | [1.21 – 1.44] | <0.001 |
| Endocrine therapy (ref: no) | | | |
| Yes | 0.74 | [0.68 – 0.81] | <0.001 |
| Immunotherapy (ref: no) | | | |
| Yes | 1.60 | [1.46 – 1.74] | <0.001 |
| cT (ref: cT0) | | | |
| 1 | 1.09 | [0.72 – 1.64] | 0.70 |
| 2 | 1.05 | [0.69 – 1.58] | 0.83 |
| 3 | 0.90 | [0.59 – 1.36] | 0.62 |
| 4 | 0.78 | [0.52 – 1.18] | 0.24 |
| cN (ref: cN1) | | | |
| 2 | 0.76 | [0.71 – 0.82] | <0.001 |
| 3 | 0.79 | [0.73 – 0.87] | <0.001 |
| Histology (ref: ductal) | | | |
| Lobular | 0.62 | [0.54 – 0.73] | <0.001 |

| | OR^a | 95% CI^b | p-value |
|----------------|-----------------------|---------------------------|------------------|
| Other | 0.75 | [0.69 – 0.82] | <0.001 |
| Grade (ref: 1) | | | |
| 2 | 1.45 | [1.21 – 1.72] | <0.001 |
| 3 | 2.32 | [1.95 – 2.76] | <0.001 |

^aOdds ratio

^bConfidence interval

^cTriple negative breast cancer

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