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PRECLINICAL STUDY

Treatment delays from transfers of care and their impact on breast cancer quality measures

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Abstract

Purpose Despite delays between diagnosis and surgery adversely affecting survival, patients frequently transfer their breast cancer care between institutions. This study was performed to assess the prevalence and effect of such transfers of care (TsOC) on the time to surgery, and its impact on current time-dependent breast cancer quality metrics at Commission on Cancer (CoC) and National Accreditation Program for Breast Centers (NAPBC)-accredited institutions.

Methods Patients having non-metastatic invasive breast cancer diagnosed between 2006 and 2015 at CoC and NAPBC centers ("reporting facilities") in the National Cancer Database were reviewed. TsOC refer to transferring into or out of a reporting facility between diagnosis and surgery.

Results Among 622,793 patients, 36.6% of patients transferred care. TsOC add 7.3, 7.8, 8.7, and 9.8 days in time to surgery, chemotherapy, radiotherapy, and endocrine therapy, respectively (p's < 0.0001). On multivariable analysis, the odds of surgery occurring > 90 days from diagnosis were greatest for patients undergoing unilateral or bilateral mastectomy, Black or Hispanic patients, and those having TsOC (ORs > 1.73, p's < 0.0001). TsOC increase the odds of non-compliance, per patient, for chemotherapy, radiotherapy and endocrine therapy time-dependent measures by 65.4%, 25.6%, and 56.5%, respectively ($p < 0.0001$).

Conclusions TsOC for newly diagnosed breast cancers to or from an accredited facility result in delays in time to surgery which can affect compliance with time-dependent quality measures. Facilities frequently receiving transferred patients may be most adversely affected. Although non-compliance with these quality measures is low, institutions and accrediting bodies should be aware of these associations in order to comply with time-dependent standards.

Keywords Breast cancer · Quality measures · Delays · Transfers of care · Second opinions

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Introduction

Delays in cancer care are a universal concern of patients, but until recently, there has been little consensus as to whether delays impact breast cancer outcomes. Recent analyses of large national datasets show that not only do delays impact overall and disease-specific survival, but waiting times between presentation and breast surgery in the United States are increasing [1]. Unfortunately in early stage breast cancer there is a relative 9–10% drop in overall survival for every month of delay, and a relative 26% decline in disease-specific survival for every 2-months of delay between diagnosis and surgery [2].

There is no current standard for time to breast cancer surgery, but three time-dependent measures for patients undergoing systemic therapy for breast cancer are endorsed by the National Quality Forum (NQF), the Commission on Cancer (CoC), the American Society of Clinical Oncology (ASCO), and the American College of Surgeons' National Accreditation Program for Breast Centers (NAPBC) [3, 4] which are also being considered by the Centers for Medicare and Medicaid Services [5]. These include time between diagnosis and start of chemotherapy of < 120 days for women under 70 with AJCC T1c, Stage II or III hormone receptor negative breast cancer; an interval between diagnosis and start of radiation of < 365 days for women under 70 having breast conservation surgery; and time between diagnosis and start of endocrine therapy of < 365 days for women with AJCC T1c, Stage II or III, hormone receptor-positive breast cancer.

These standards exist because delays have a detrimental effect, but some components required to evaluate and plan breast cancer treatment each have an inextricable time cost themselves, and more complex planned case components (such as reconstruction or axillary dissection) are correlated with a longer time to operation [1] likely because of the logistics of scheduling. Even pre-operative multidisciplinary assessment, which is endorsed as beneficial for breast center accreditation [3], has been found to delay surgery by 1 week and by nearly 2 weeks if not coordinated on the same day [6].

Patients today frequently obtain second opinions [7] and transfer care between providers, but it remains unknown whether transfers of care (TsOC) after breast cancer diagnosis affect the timing of surgery and adjuvant therapies. If transfers cause significant delays, centers with high volumes of patients transferring in from other institutions after diagnosis could potentially see an effect on their patients' outcomes and face challenges in maintaining compliance with these time-dependent standards. To our knowledge, there are no data regarding the impact of transferring institutions on the timeliness of breast cancer surgery or the ability to remain compliant with the current quality measures. This study was performed to fill these voids and is the first to assess the impact of TsOC on time to surgery and compliance with time-dependent breast cancer quality measures.

Methods

Data source

The National Cancer Database (NCDB) is a prospectively collected dataset comprising 70% of patients at Commission on Cancer-accredited Hospitals in the United States [8]. These hospitals transmit diagnosis and treatment data to the NCDB for their patients, and are referred to as the "reporting facilities." Patients are defined here as 'transferring care' if they transferred to or from an institution other than the reporting facility between diagnosis and surgery. The study time frame was 2004 through 2015 and cohort exclusions are elaborated in Fig. 1.

Data variables

Three quality measures were evaluated for compliance. The first is referred to as the "Chemotherapy Measure:" The time between diagnosis and start of chemotherapy for women under 70 with AJCC T1c, Stage II or III hormone receptor negative breast cancer having chemotherapy, must be within 120 days of diagnosis. The second is labeled "radiotherapy measure:" The time between diagnosis and start of radiation for women under 70 having breast conservation surgery and radiation therapy for breast cancer, must be within 365 days of diagnosis. The third is labeled "Endocrine Therapy Measure:" The time between diagnosis and start of endocrine therapy for women with AJCC T1c, Stage II or III, hormone receptor-positive breast cancer having endocrine therapy, must be within 365 days of diagnosis. In each case, the patients included were based upon the definition of the standard itself. The total cohort is the sum of the three.

Ductal tumors included subtypes and those having mixed ductal and other features. Hormone receptor-positive tumor status was defined as being estrogen receptor and/or progesterone receptor-positive as defined by the College of American Pathologists (CAP) in that year. HER2/*neu* status was not included due to the fact that these data were not collected until 2010, making analysis impossible across the entire cohort time frame. The NCDB now censors institution type for women < 40 years of age, so instead, we used facility volumes, divided into low volume centers (0–50 cases/year), mid-volume centers (51–100 cases/year), and high-volume centers (≥ 101 cases/year).

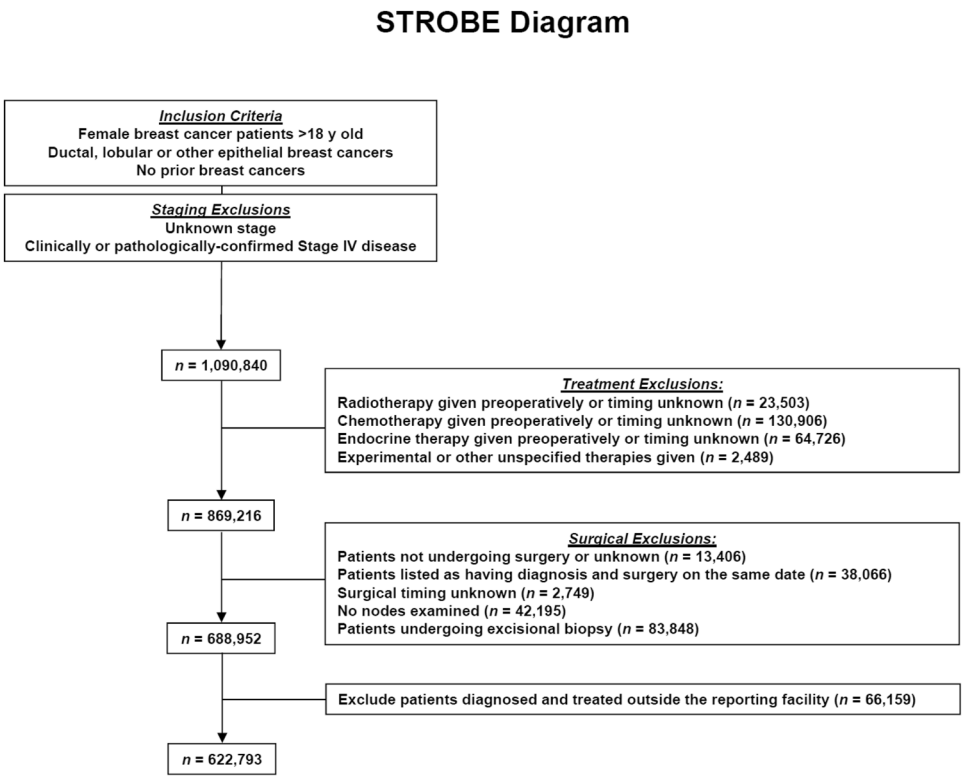

Fig. 1 Cohort inclusion and exclusion criteria

Determination of the location of diagnosis was based upon class of case which is specific for being at, or outside, the reporting facility. Class of case is not as clear, however, for treatment location (e.g., many categories only specify that "part or all" of treatment is at the reporting facility), so surgical procedure of the primary site, and surgery at this facility variables were used to determine whether surgery was performed, and if so, the location of that surgery, respectively. These allowed assessment of whether TsOC occurred between diagnosis and surgery.

Statistical analysis

Patient, facility, and tumor characteristics were compared between patients categorized as having TsOC or not using descriptive statistics. Times between modalities were compared using Mann–Whitney *U* tests. Multivariable regression models were used to identify factors associated with longer delay between diagnosis and definitive surgery, chemotherapy, endocrine therapy, radiotherapy, adjusting for patient, facility, and tumor variables described earlier. Adjusted delays were computed using parameters estimated in the multivariable models with log-transformed outcome due to skewed times from diagnosis to modalities.

Quality measure compliance was analyzed at the patient and facility levels. For patient level outcomes, compliance was assessed evaluating the percentage of those having and not having TsOC. Patients compliant and non-compliant with each measure were compared using Mann–Whitney *U* tests. Multivariable logistic regression models accounting for patients nesting within facilities were performed to identify non-compliant factors with each measure, adjusting for patient, facility, and tumor variables described earlier.

For facility level outcomes, aggregated patient data from each facility were utilized to compute compliance. Facilities were measured using both a 90% benchmark, and because of high compliance, a 100% threshold for each measure. Statistical analysis was performed using SAS, version 9.3 (SAS Inc., Cary, NC). All tests were two-sided, and p-value ≤ 0.05 was considered statistically significant.

Results

Among the 622,793 patients from 2004 to 2015, 394,764 (63.4%) remained at the reporting facility, and 228,029 (36.6%) had TsOC. Transfers increased from 29.1% in 2004 to 39.6% in 2015 ($p < 0.001$, Fig. 2). Patients who did not transfer care were similarly distributed between low (34.7%), middle (33.9%) and high (31.3%) volume centers, while patients in the TsOC cohort most frequently did so to or from a high-volume center (42.9%). Among other factors, younger patients, Hispanic patients, patients having non-Medicare governmental insurance, and those having bilateral mastectomy were more likely to transfer care, while Blacks,

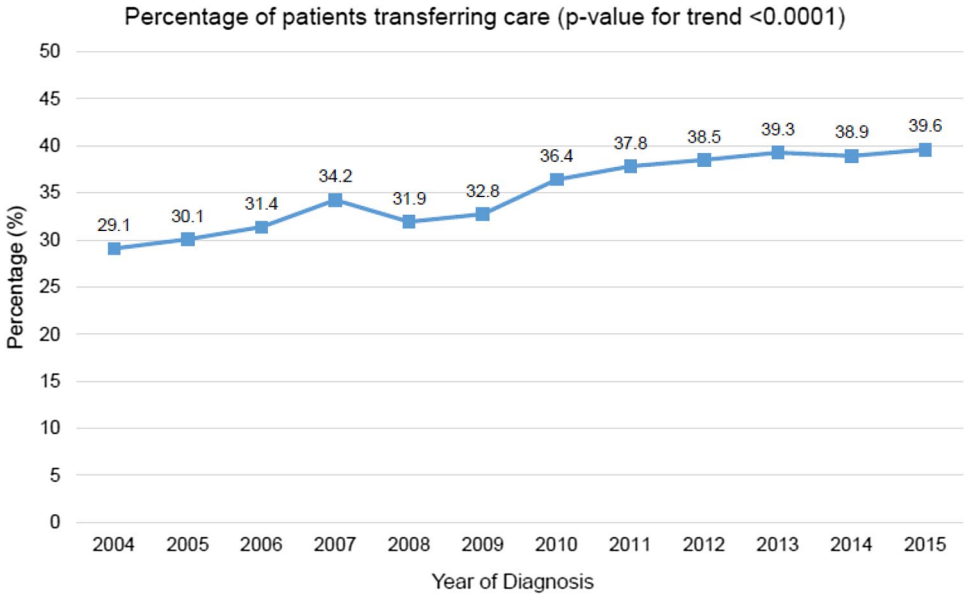

Fig. 2 Transfers of care by year. Illustrated here is the trend in those transferring care between institutions over time, demonstrating a 36% increase from 2004 to 2015

the uninsured, and those from urban areas and the poorest zip codes were less likely to do so (Table 1).

The largest delays associated with TsOC were all between diagnosis and surgery, rather than between treatments (Table 2), consistent with the fact that the transfers occurred within this interval. The difference in the means (95% CIs) associated with a transfer of care from diagnosis to surgery, chemotherapy, radiotherapy, and endocrine therapy was 7.3 (7.1–7.4), 7.8 (7.4–8.2), 8.7 (8.1–9.2), and 9.8 (9.2–10.4) days, respectively, whereas the mean delays associated with TsOC between treatment modalities were all $\leq$2.5 days.

Variables increasing the likelihood that time between diagnosis and surgery was >90 days [2] are listed in Table 3. Adjusting for all other variables, factors that nearly or more than doubled the odds of having a time between diagnosis and surgery >90 days were bilateral mastectomy (OR 3.144, 95% CI 2.996–3.300, $p<0.0001$), Black race (OR 2.693, 95% CI 2.563–2.829, $p<0.0001$) and Hispanic ethnicity (OR 1.942, 95% CI 1.820 to 2.073, $p<0.0001$), and unilateral mastectomy (OR 2.233, 95% CI 2.135–2.336, $p<0.0001$), while TsOC increased that likelihood by 76.6% (OR 1.766, 95% CI 1.703–1.832, $p<0.0001$). Factors lowering the odds that the time to surgery was >90 days included those living in all regions of the country except the Pacific, private insurance (OR 0.393, 95% CI 0.356–0.434, $p<0.0001$) and Medicare (OR 0.468, 95% CI 0.422–0.520, $p<0.0001$), dwelling in wealthiest zip codes (mean incomes >$63,000; OR 0.736, 95% CI 0.695–0.779, $p<0.0001$), living in a rural region (OR 0.682, 95% CI 0.560–0.831, $p=0.0080$), and those having tumors that were triple negative (OR 0.736, 95% CI 0.674–0.802, $p<0.0001$).

Adjusted times attributable to each patient demographic, tumor and treatment factor are listed in Table 4. As noted in Table 5, TsOC increased the odds of non-compliance for an individual patient by 65.4%, 56.5% and 25.6% for chemotherapy, radiotherapy, and endocrine therapy, respectively. Non-compliance for the chemotherapy measure was greatest for patients having a bilateral mastectomy (OR 2.930, 95% CI 2.542–3.378, $p<0.0001$), Black race (OR 2.248, 95% CI 1.966–2.571, $p<0.0001$), and those having TsOC (OR 1.654, 95% CI 1.481–1.847, $p<0.0001$). Non-compliance for the radiotherapy measure was greatest in patients who had pN3 disease (OR 5.366, 95% CI 3.434–8.385, $p<0.0001$), tumors >5 cm (OR 3.152, 95% CI 1.665–5.967, $p=0.0263$), and Black race (OR 2.632, 95% CI 2.106–3.288, $p=0.0005$). TsOC increased this to a lesser degree with an OR of 1.565 (95% CI 1.311–1.869, $p<0.0001$). Factors increasing non-compliance for the endocrine therapy measure were greatest in patients having pN2 (OR 3.779, 95% CI 3.104–4.602, $p<0.0001$) or pN3 disease (OR 3.351, 95% CI 2.847–3.945, $p<0.0001$), and Black race (OR 2.329, 95% CI 2.102–2.581, $p<0.0001$). TsOC contributed to a lesser degree with an OR of 1.256 (95% CI 1.163–1.356, $p<0.0001$).

Irrespective of these factors, over 90% of patients' care was compliant for all measures, with a statistically significant, but small drop in compliance for those patients having TsOC (Table 6). When defining compliance as having 90% of patients at a facility having compliant care, the overwhelming majority of centers were compliant for each measure, although the chemotherapy measure posed the greatest risk of non-compliance among the three (Table 7). This was more evident when increasing the compliance threshold to 100%, whereby the radiotherapy measure was easiest to perfect, and only a minority of centers were 100% compliant for the other two standards.

Table 1 Cohort demographics

	Overall	No transfer of care		Transfer of care		*p*-value
	n	*n*	%	*n*	%	
Total	622,793	394,764	63.39	228,029	36.61	< 0.0001
Facility location						< 0.0001
New England	39,880	28,292	70.94	11,588	29.06	
Middle Atlantic	86,031	49,698	57.77	36,333	42.23	
South Atlantic	140,169	85,295	60.85	54,874	39.15	
East North Central	122,380	87,315	71.35	35,065	28.65	
East South Central	40,417	25,637	63.43	14,780	36.57	
West North Central	49,127	34,223	69.66	14,904	30.34	
West South Central	45,788	25,617	55.95	20,171	44.05	
Mountain	29,680	16,326	55.01	13,354	44.99	
Pacific	69,321	42,361	61.11	26,960	38.89	
Facility volume						< 0.0001
Low (0–50 cases/year)	194,528	137,333	70.60	57,195	29.40	
Mid (51–100 cases/year)	206,961	133,952	64.72	73,009	35.28	
High (> 100 cases/year)	221,304	123,479	55.80	97,825	44.20	
Age						< 0.0001
< 50	149,764	89,015	59.44	60,749	40.56	
50–70	332,113	210,073	63.25	122,040	36.75	
> 70	140,916	95,676	67.90	45,240	32.10	
Race and ethnicity						< 0.0001
White	499,746	317,525	63.54	182,221	36.46	
Black	63,542	41,995	66.09	21,547	33.91	
Hispanic	29,518	17,684	59.91	11,834	40.09	
Asian/Pacific Islander	20,559	12,442	60.52	8117	39.48	
Other/unknown	9428	5118	54.29	4310	45.71	
Insurance						< 0.0001
Not insured	10,522	7381	70.15	3141	29.85	
Private insurance	347,791	212,707	61.16	135,084	38.84	
Medicaid	33,143	21,481	64.81	11,662	35.19	
Medicare	218,784	145,665	66.58	73,119	33.42	
Other government	6056	3291	54.34	2765	45.66	
Unknown	6497	4239	65.25	2258	34.75	
Income						< 0.0001
Less than $38,000	86,856	57,067	65.70	29,789	34.30	
$38,000–$47,999	129,953	84,016	64.65	45,937	35.35	
$48,000–$62,999	166,810	106,994	64.14	59,816	35.86	
$63,000+	236,238	144,964	61.36	91,274	38.64	
Urban/rural						< 0.0001
Metropolitan	526,534	335,223	63.67	191,311	36.33	
Urban	70,132	43,643	62.23	26,489	37.77	
Rural	8721	5307	60.85	3414	39.15	
Histology						0.0025
Mixed carcinoma	3374	2190	64.91	1184	35.09	
Ductal	570,401	361,807	63.43	208,594	36.57	
Lobular	49,018	30,767	62.77	18,251	37.23	

Table 1 (continued)

	Overall	No transfer of care		Transfer of care		*p*-value
	n	*n*	%	*n*	%	
Grade						< 0.0001
Grade 1	137,270	90,477	65.91	46,793	34.09	
Grade 2	259,447	162,940	62.80	96,507	37.20	
Grade 3 and undifferentiated/anaplastic	185,363	116,082	62.62	69,281	37.38	
Unknown	40,713	25,265	62.06	15,448	37.94	
Surgery type						<0.0001
Lumpectomy	386,690	251,519	65.04	135,171	34.96	
Single mastectomy	148,115	95,529	64.50	52,586	35.50	
bilateral mastectomy	87,749	47,611	54.26	40,138	45.74	
Tumor size (cm)						< 0.0001
< 1	196,010	126,250	64.41	69,760	35.59	
1.1–2.0	225,145	142,075	63.10	83,070	36.90	
2.1–3.0	103,029	64,615	62.72	38,414	37.28	
3.1–4.0	36,036	22,655	62.87	13,381	37.13	
4.1–5.0	16,225	10,133	62.45	6092	37.55	
> 5	21,387	13,618	63.67	7769	36.33	
Nodal status						< 0.0001
pN0	394,680	248,035	62.84	146,645	37.16	
pN1	89,092	55,030	61.77	34,062	38.23	
pN2	19,913	12,405	62.30	7508	37.70	
pN3	9202	5812	63.16	3390	36.84	
pNX	94,925	63,972	67.39	30,953	32.61	
Molecular marker status						< 0.0001
HER2+, HR+	31,993	19,605	61.28	12,388	38.72	
HER2+, HR−	12,568	7472	59.45	5096	40.55	
HER2−, HR+	279,704	172,420	61.64	107,284	38.36	
HER2−, HR−	34,176	20,715	60.61	13,461	39.39	

HR hormone receptor-positive (ER and/or PR positive)

Discussion

We have confirmed that TsOC between institutions in the interval between diagnosis and surgery is associated with a delay in care. Delays in breast cancer treatment have received more attention in recent years because of the established adverse effects of longer times to treatment on patient outcomes. In breast cancer, longer times to surgery have been demonstrated to lower disease-specific and overall survival [2, 9] but not all factors are easily controlled. Delays can be subdivided into those due to the medical system, due to the providers, and those due to the patient, the last of which may be the least likely to be influenced by the physician.

Many TsOC may result from patients seeking second opinions, which are perceived as valuable, but remain controversial [7, 10] and we have now confirmed that these TsOC are associated with a time cost. Appointment scheduling, transferring records, and in some cases repeating or ordering additional tests with the need to reschedule treatment must then ensue. These processes will need to become an increasing area of focus for institutions who are judged on times to chemotherapy, radiotherapy, and endocrine therapy [11, 12] especially as we have noted that TsOC have increased from 2004 to 2015 by a relative 36%.

This increase in TsOC, likely due to second opinions, is probably multifactorial. Second opinions in oncology are sought in up to 88% of cases, often motivated by a desire for treatment confirmation, better communication, and even a lack of trust [7]. Second opinions differ from a primary opinion in up to 69% of cases and are perceived as helpful by patients [10]. Meanwhile increasing openness and patient-to-patient communication about cancer diagnoses and experiences [13] in recent years also probably contributes substantially to this trend.

Although certain delays, such as those due to second opinions, are out of the control of the provider, institutions remain responsible to adhere to current quality measures without exception when calculating compliance rates.

Table 2 Times between modalities in days

	Overall				No transfer of care				Transfer of care				Mean Δ (days)	95% CI mean	*p*-value*
	Mean	Median	SD	IQR	Mean	Median	SD	IQR	Mean	Median	SD	IQR			
Diagnosis to definitive surgery	39.7	33.0	30.6	22–50	37.6	31.0	29.1	21–47	44.9	37.0	34.1	25–55	7.3	7.1 to 7.4	< 0.0001
Diagnosis to chemotherapy	81.2	74.0	42.1	57–96	78.4	71.0	40.7	56–92	86.2	78.0	44.7	62–101	7.8	7.4 to 8.2	< 0.0001
Diagnosis to radiotherapy	127.5	98.0	77.6	68–182	123.5	95.0	76.7	67–178	132.2	104.0	78.3	72–189	8.7	8.1 to 9.2	< 0.0001
Diagnosis to endocrine therapy	152.3	133.0	93.2	81–203	147.4	128.0	92.0	78–198	157.2	138.0	93.9	86–212	9.8	9.2 to 10.4	< 0.0001
Definitive surgery to chemotherapy	44.4	40.0	31.3	30–51	43.8	39.0	30.6	30–51	44.9	40.0	32.8	30–52	1.1	0.9 to 1.4	< 0.0001
Definitive surgery to radiotherapy	28.7	21.0	34.3	7–36	27.0	20.0	30.7	7–36	29.3	21.0	36.5	7–38	2.3	1.8 to 2.8	< 0.0001
Definitive surgery to endocrine therapy	32.7	27.0	29.9	15–39	30.8	27.0	24.9	15–39	33.3	27.0	31.5	15–42	2.5	1.9 to 3.1	< 0.0001
Chemotherapy to radiotherapy	131.8	131.0	41.2	99–158	131.2	130.0	41.4	98–157	131.8	131.0	40.9	100–158	0.6	0.1 to 1.3	0.3544
Chemotherapy to endocrine therapy	115.9	117.0	45.2	84–144	115.3	115.0	45.6	84–143	116.1	117.0	44.0	85–144	0.8	0.6 to 2.2	0.0003
Radiotherapy to endocrine therapy	59.5	52.0	47.8	38–69	59.3	52.0	47.8	38–69	59.2	52.0	46.7	38–69	−0.1	−0.4 to 0.5	0.2060

Adjusted intervals between components of treatments are shown with their ranges. Patients having a transfer of care between diagnosis and surgery have interval lengths that are significantly longer than those who stay at the institution where they were diagnosed. Additionally, as illustrated by the standard deviations and the interquartile ranges, there is a wide variation in the lengths of the intervals for both types of patients: those having and those not having a transfer of care between diagnosis and surgery. The p values are non-parametric because of the skewed distributions

SD standard deviation, *IQR* interquartile range

*Non-parametric: Mann–Whitney *U* test

Table 3 Multivariable analysis for predictors of delay from diagnosis to definitive surgery > 90 days

	Time to definitive surgery			
	OR	95% CI		*p*-value
Facility location				
New England (ref)	–	–	–	–
Middle Atlantic	0.988	0.909	1.072	< 0.0001
South Atlantic	0.732	0.675	0.793	< 0.0001
East North Central	0.651	0.598	0.709	0.9419
East South Central	0.367	0.325	0.413	< 0.0001
West North Central	0.362	0.322	0.407	< 0.0001
West South Central	0.593	0.537	0.655	0.0033
Mountain	0.518	0.459	0.585	< 0.0001
Pacific	1.113	1.021	1.212	< 0.0001
Facility volume				
Low (0–50 cases/year) (ref)	–	–	–	–
Mid (51–100 cases/year)	0.994	0.950	1.040	0.1684
High (> 100 cases/year)	0.937	0.895	0.980	0.0013
Class of case				
No transfer of care (ref)	–	–	–	–
Transfer of care	1.766	1.703	1.832	< 0.0001
Age				
< 50 (ref)	–	–	–	–
50–70	1.019	0.974	1.066	0.0004
> 70	0.909	0.850	0.973	0.0004
Race and ethnicity				
White (ref)	–	–	–	–
Black	2.693	2.563	2.829	< 0.0001
Hispanic	1.942	1.820	2.073	< 0.0001
Asian/Pacific Islander	1.317	1.207	1.437	< 0.0001
Other/unknown	1.453	1.268	1.665	0.1200
Insurance				
Not insured (ref)	–	–	–	–
Private insurance	0.393	0.356	0.434	< 0.0001
Medicaid	0.895	0.804	0.996	< 0.0001
Medicare	0.468	0.422	0.520	< 0.0001
Other government	0.645	0.539	0.771	0.8775
Income				
Less than $38,000 (ref)	–	–	–	–
$38,000–$47,999	0.872	0.823	0.924	0.1991
$48,000–$62,999	0.826	0.780	0.875	0.0401
$63,000+	0.736	0.695	0.779	< 0.0001
Urban/rural				
Metropolitan (ref)	–	–	–	–
Urban	0.795	0.744	0.850	0.5209
Rural	0.682	0.560	0.831	0.0080
Histology				
Mixed carcinoma (ref)	–	–	–	–
Ductal	1.004	0.764	1.319	0.5045
Lobular	1.109	0.840	1.465	0.1783
Grade				
Grade 1 (ref)	–	–	–	–
Grade 2	1.026	0.980	1.073	< 0.0001
Grade 3 and undifferentiated/anaplastic	0.862	0.813	0.913	< 0.0001
Surgery type				
Lumpectomy (ref)	–	–	–	–
Single mastectomy	2.233	2.135	2.336	< 0.0001
Bilateral mastectomy	3.144	2.996	3.300	< 0.0001
Tumor size (cm)				
< 1 (ref)	–	–	–	–
1.1–2.0	0.768	0.735	0.803	0.0004
2.1–3.0	0.752	0.712	0.796	< 0.0001
3.1–4.0	0.770	0.712	0.834	0.0349
4.1–5.0	0.860	0.774	0.956	0.2920
> 5	0.810	0.734	0.894	0.6882
Nodal status				
pN0 (ref)	–	–	–	–
pN1	0.970	0.926	1.017	< 0.0001
pN2	0.853	0.778	0.936	< 0.0001
pN3	0.947	0.834	1.076	0.0012
pNX	2.285	2.017	2.588	< 0.0001
Molecular marker status				
HER2+, HR+ (ref)	–	–	–	–
HER2+, HR−	0.998	0.897	1.111	0.0354
HER2−, HR+	0.996	0.935	1.060	0.0002
HER2−, HR−	0.736	0.674	0.802	< 0.0001

The threshold of 90 days was utilized because of the 3–5% drop in OS with delays of this magnitude [2] A markedly greater likelihood of having a time between diagnosis and surgery > 90 days is notable in the Pacific region of the United States, patients having transfers of care, Black and Hispanic patients, those having an unknown nodal status, and those having unilateral or bilateral mastectomy

Ref referent

Institutions that have larger proportions of patients having TsOC from other institutions may therefore be at an inherent disadvantage when attempting to comply with these standards. We could not evaluate institution type (e.g., academic versus non-academic centers) because the NCDB now censors these data for women < 40 years of age, so instead we evaluated facility volume, which could be a surrogate for academic centers, and may be more broadly applicable as many private institutions are high-volume centers. We found that centers with high volume were more likely to have patients with TsOC, but less likely to experience non-compliance with the time-dependent quality measures of chemotherapy and radiotherapy administration (Table 5). This may be attributable to high-volume efficiencies such as standardization of care, electronic medical records, or patient navigation.

Table 4 Multivariable analysis with log-transformed time delay outcome

Therapy interval	Time, diagnosis to definitive surgery				Time, diagnosis to chemotherapy				Time, diagnosis to radiotherapy				Time, diagnosis to endocrine therapy			
	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value
Facility location																
New England (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Middle Atlantic	0.8110	0.4357	1.2122	< 0.0001	4.6094	3.5261	5.7657	< 0.0001	6.2182	4.7618	7.7728	< 0.0001	−5.9515	−7.3555	−4.3879	< 0.0001
South Atlantic	−2.7930	−2.9979	−2.5668	< 0.0001	−3.7504	−4.4327	−3.0057	< 0.0001	−6.9813	−7.8015	−6.0790	< 0.0001	−8.6348	−9.8461	−7.2776	< 0.0001
East North Central	−3.2976	−3.4837	−3.0907	< 0.0001	−4.9396	−5.5697	−4.2409	< 0.0001	−5.6481	−6.5272	−4.6711	< 0.0001	−8.4517	−9.6876	−7.0852	< 0.0001
East South Central	−8.0988	−8.1361	−8.0446	< 0.0001	−9.3968	−10.0007	−8.7255	< 0.0001	−11.5982	−12.5363	−10.5427	< 0.0001	−27.0783	−27.7593	−26.2777	< 0.0001
West North Central	−8.1159	−8.1280	−8.0892	< 0.0001	−12.8568	−13.2454	−12.4217	< 0.0001	−16.7158	−17.2710	−16.0813	< 0.0001	−28.7111	−29.1573	−28.1664	< 0.0001
West South Cental	−4.7853	−4.9614	−4.5896	< 0.0001	−5.3619	−6.1205	−4.5299	< 0.0001	−12.0432	−12.9147	−11.0852	< 0.0001	−17.0175	−18.1735	−15.7175	< 0.0001
Mountain	−5.0534	−5.2533	−4.8309	< 0.0001	−8.8949	−9.5810	−8.1344	< 0.0001	−14.0313	−14.8892	−13.0584	< 0.0001	−21.0260	−22.1424	−19.7752	< 0.0001
Pacific	−0.5751	−0.9104	−0.2146	0.0022	0.8505	−0.1250	1.9063	0.0895	−2.7709	−3.9006	−1.5390	< 0.0001	−2.0702	−3.7764	−0.2183	0.0296
Facility volume																
Low (0–50 cases/year) (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mid (51–100 cases/year)	1.7125	1.4734	1.9677	< 0.0001	0.7982	0.3344	1.3057	0.0006	−1.9015	−2.4474	−1.2950	< 0.0001	−1.5680	−2.3890	−0.6723	0.0008
High (> 100 cases/year)	2.3708	2.1023	2.6528	< 0.0001	0.5805	0.1169	1.0702	0.0135	−1.6930	−2.2599	−1.0777	< 0.0001	−1.9145	−2.7204	−1.0346	< 0.0001
Class of case																
No transfer of care (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Transfer of care	5.4915	5.1369	5.8656	< 0.0001	6.7911	6.1651	7.4457	< 0.0001	4.8420	4.1290	5.6180	< 0.0001	7.7806	6.7092	8.9317	< 0.0001
Age																
< 50 (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
50–70	−0.0765	−0.2561	0.1210	0.4453	3.3089	2.7816	3.8720	< 0.0001	−13.7477	−13.8722	−13.6024	< 0.0001	−19.8668	−19.9341	−19.7590	< 0.0001
> 70	−0.8290	−1.0576	−0.5845	< 0.0001	3.6953	2.7643	4.6964	< 0.0001	−32.9455	−32.4950	−33.3654	< 0.0001	−54.3155	−53.1469	−55.4899	< 0.0001
Race and ethnicity																
Caucasian (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Black	8.3761	7.7903	8.9959	< 0.0001	13.1463	12.0574	14.3016	< 0.0001	18.5941	16.9176	20.3613	< 0.0001	21.8196	19.5084	24.2790	< 0.0001

Table 4 (continued)

Therapy interval	Time, diagnosis to definitive surgery				Time, diagnosis to chemotherapy				Time, diagnosis to radiotherapy				Time, diagnosis to endocrine therapy			
	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value
Hispanic	6.6784	6.0590	7.3427	< 0.0001	10.3795	9.1615	11.6806	< 0.0001	15.0942	13.1860	17.1382	< 0.0001	13.8564	11.4617	16.4273	< 0.0001
API	1.8004	1.3307	2.3028	< 0.0001	3.7403	2.6438	4.9225	< 0.0001	7.2873	5.4906	9.2274	< 0.0001	−0.5766	−2.5050	1.5355	0.5796
Other/ unknown	1.5145	0.8443	2.2467	< 0.0001	3.4884	1.8385	5.2911	< 0.0001	5.5421	3.0550	8.2658	< 0.0001	4.6277	1.2667	8.3025	0.0058
Insurance																
Not insured (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Private insurance	−5.5828	−5.8493	−5.2821	< 0.0001	−11.4619	−12.0851	−10.7723	< 0.0001	−13.8896	−15.1701	−12.4498	< 0.0001	−14.0514	−16.0880	−11.7797	< 0.0001
Medicaid	0.6177	−0.0141	1.3019	0.0553	−0.0777	−1.3652	1.3148	0.9058	−1.3797	−3.5173	0.9483	0.2375	−0.2448	−3.3482	3.1581	0.8794
Medicare	−4.6011	−4.9281	−4.2362	< 0.0001	−7.3063	−8.1797	−6.3351	< 0.0001	−18.1832	−19.3002	−16.9365	< 0.0001	−21.9164	−23.5818	−20.0184	< 0.0001
Other government	−2.1884	−2.9205	−1.3788	< 0.0001	−4.8011	−6.4984	−2.9366	< 0.0001	−8.2138	−10.8822	−5.2650	< 0.0001	−6.3905	−10.4154	−1.9194	0.0062
Income																
Less than $38,000 (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
$38,000–$47,999	−0.3664	−0.5934	−0.1244	0.0039	−2.1743	−2.6757	−1.6211	< 0.0001	−1.3405	−2.1723	−0.4239	0.0047	0.3328	−0.9396	1.7008	0.6250
$48,000–$62,999	−0.5464	−0.7626	−0.3158	< 0.0001	−2.6946	−3.1747	−2.1724	< 0.0001	−2.4342	−3.2072	−1.5796	< 0.0001	0.0700	−1.1570	1.4071	0.9104
$63,000+	−1.2962	−1.4817	−1.0939	< 0.0001	−4.3595	−4.7795	−3.8996	< 0.0001	−4.0064	−4.7129	−3.2346	< 0.0001	1.0884	−0.1850	2.4926	0.0954
Urban/rural																
Metropolitan (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Urban	−1.9787	−2.1264	−1.8127	< 0.0001	−2.6946	−3.1667	−2.1898	< 0.0001	−1.3797	−2.1723	−0.5195	0.0021	−4.0988	−5.0707	−3.0147	< 0.0001
Rural	−2.0476	−2.5242	−1.5276	< 0.0001	−2.5271	−3.8539	−1.0840	0.0009	−2.4083	−4.4551	−0.1643	0.0364	−4.3038	−6.9528	−1.3782	0.0049
Histology																
Mixed carcinoma (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ductal	−0.1964	−1.1769	0.8824	0.7091	−1.2176	−3.4471	1.2422	0.3204	−0.5536	−4.2829	3.5796	0.7861	4.6816	−1.0734	11.1212	0.1145
Lobular	1.6248	0.5106	2.8554	0.0035	−0.2501	−2.6353	2.3732	0.8442	3.9548	−0.1528	8.4983	0.0597	6.3604	0.3874	13.0234	0.0363
Grade																
Grade 1 (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grade 2	0.1095	−0.0668	0.2995	0.2321	−0.4651	−1.0939	0.2238	0.1819	13.8485	12.6669	15.1023	< 0.0001	15.2782	13.7769	16.8843	< 0.0001
Grade 3 and undifferentiated/ anaplastic	−1.7885	−1.9373	−1.6253	< 0.0001	−3.4691	−3.9970	−2.8847	< 0.0001	37.0264	34.6822	39.4995	< 0.0001	47.7364	44.5092	51.1890	< 0.0001

Table 4 (continued)

Therapy interval	Time, diagnosis to definitive surgery				Time, diagnosis to chemotherapy				Time, diagnosis to radiotherapy				Time, diagnosis to endocrine therapy			
	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value	Estimate	95% CI		*p*-value
Surgery type																
Lumpectomy (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Single mastectomy	5.0325	4.6517	5.4358	< 0.0001	7.4360	6.7042	8.2138	< 0.0001	17.9625	16.0400	20.0156	< 0.0001	−30.9324	−30.5276	−31.3188	< 0.0001
Bilateral mastectomy	15.5279	14.6885	16.4158	< 0.0001	19.0250	17.7893	20.3403	< 0.0001	34.9089	31.9344	38.0759	< 0.0001	−15.5254	−15.9357	−15.0675	< 0.0001
Tumor size (cm)																
< 1 (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1.1–2.0	−0.9464	−1.0780	−0.8031	< 0.0001	−3.3612	−3.7664	−2.9106	< 0.0001	17.7077	16.3847	19.0922	< 0.0001	19.1609	17.4729	20.9839	< 0.0001
2.1–3.0	−1.1518	−1.3263	−0.9654	< 0.0001	−4.4086	−4.8188	−3.9594	< 0.0001	33.7439	31.5207	36.0918	< 0.0001	36.1119	33.3648	39.0394	< 0.0001
3.1–4.0	−1.3770	−1.6432	−1.0903	< 0.0001	−4.5887	−5.1404	−3.9935	< 0.0001	38.6065	35.5923	41.8263	< 0.0001	42.5413	38.8000	46.5708	< 0.0001
4.1–5.0	−1.2188	−1.6298	−0.7736	< 0.0001	−4.0637	−4.8659	−3.1870	< 0.0001	35.6956	32.0779	39.5701	< 0.0001	49.6827	44.6157	55.1639	< 0.0001
> 5	−1.6809	−2.0436	−1.2877	< 0.0001	−5.6529	−6.3367	−4.9025	< 0.0001	38.3507	34.8768	42.0589	< 0.0001	66.7465	61.0117	72.8976	< 0.0001
Nodal status																
pN0 (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
pN1	0.1022	−0.0879	0.3071	0.2981	−2.2332	−2.5545	−1.8928	< 0.0001	57.7133	54.6338	60.9460	< 0.0001	69.8119	65.8304	74.0218	< 0.0001
pN2	−0.7898	−1.1292	−0.4168	< 0.0001	−4.1871	−4.6693	−3.6512	< 0.0001	81.6349	76.5719	86.9834	< 0.0001	127.3822	119.1777	136.1075	< 0.0001
pN3	−0.8931	−1.4041	−0.3383	0.0021	−5.3376	−6.0432	−4.5638	< 0.0001	77.6124	71.8548	83.7375	< 0.0001	120.6545	111.1852	130.8074	< 0.0001
pNX	4.2720	3.4621	5.1517	< 0.0001	6.8377	1.5322	12.8395	0.0100	−16.1374	−17.7654	−14.3035	< 0.0001	−22.5276	−24.7776	−19.9698	< 0.0001
Molecular marker status																
HER2+, HR+ (ref)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
HER2+, HR−	−0.2435	−0.6764	0.2234	0.2968	−1.7692	−2.4897	−0.9957	< 0.0001	−1.3405	−3.0332	0.5214	0.1537	−43.7398	−48.5210	−38.1235	< 0.0001
HER2−, HR+	0.3517	0.0846	0.6397	0.0090	4.4004	3.7350	5.1113	< 0.0001	−35.2967	−34.7266	−35.8423	< 0.0001	−48.4066	−47.4385	−49.3871	< 0.0001
HER2−, HR−	−1.9891	−2.2255	−1.7264	< 0.0001	−4.2856	−4.6929	−3.8397	< 0.0001	−2.2266	−3.3561	−1.0098	0.0005	−43.3323	−46.1632	−40.0248	< 0.0001

Each value represents the number of days that each factor adds to or subtracts from the time of each therapy interval, relative to the referent category in that variable. For instance, the greatest contributors of delay between diagnosis and surgery were bilateral mastectomy, adding 15.5 days, with Black race at 8.4 days, Hispanic ethnicity at 6.7 days, and TsOC adding 5.5 days. These delays were magnified when evaluating time from diagnosis to chemotherapy, radiotherapy, and endocrine therapy. From time of diagnosis to chemotherapy, radiotherapy, and endocrine therapy, transfer added 6.8, 4.8, and 7.9 days, respectively, while Black race added 13.1, 18.6, and 21.8 days, and Hispanic ethnicity added 10.4, 15.1, and 13.9 days. Bilateral mastectomies added 19.0 and 34.9 days for times to chemotherapy and radiotherapy, but endocrine therapy was 15.5 days shorter

Table 5 Multivariable analysis of predictors of non-compliance with each measure for an individual patient

	Chemotherapy measure				Radiation therapy measure				Endocrine therapy measure			
	OR	95% CI		*p*-value	OR	95% CI		*p*-value	OR	95% CI		*p*-value
Facility location												
New England (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Middle Atlantic	1.226	0.924	1.628	< 0.0001	1.323	0.876	1.998	< 0.0001	1.037	0.860	1.251	0.0036
South Atlantic	0.855	0.646	1.130	0.0845	0.889	0.587	1.347	0.8179	0.792	0.659	0.951	0.0033
East North Central	0.848	0.638	1.129	0.1534	0.911	0.596	1.393	0.6631	0.904	0.751	1.087	0.9397
East South Central	0.573	0.404	0.813	0.0081	0.803	0.459	1.404	0.6918	0.819	0.651	1.029	0.2047
West North Central	0.472	0.324	0.690	0.0002	0.560	0.309	1.014	0.0448	0.522	0.411	0.663	< 0.0001
West South Cental	0.670	0.485	0.926	0.1433	0.952	0.587	1.544	0.5438	1.148	0.935	1.410	< 0.0001
Mountain	0.535	0.355	0.806	0.0141	0.477	0.230	0.990	0.0391	0.691	0.532	0.896	0.0050
Pacific	1.107	0.817	1.500	< 0.0001	1.277	0.822	1.983	0.0027	1.548	1.282	1.870	< 0.0001
Facility volume												
Low (0–50 cases/yr) (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Mid (51–100 cases/year)	0.888	0.776	1.017	0.5563	0.769	0.622	0.950	0.2969	0.823	0.751	0.902	0.6869
High (> 100 cases/year)	0.846	0.739	0.969	0.0693	0.722	0.582	0.895	0.0457	0.700	0.637	0.769	< 0.0001
Class of case												
No transfer of care (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Transfer of care	1.654	1.481	1.847	< 0.0001	1.565	1.311	1.869	< 0.0001	1.256	1.163	1.356	< 0.0001
Age												
< 50 (ref)	–	–	–	–	–	–	–	–	–	–	–	–
50–70	1.369	1.211	1.547	< 0.0001	0.839	0.691	1.018	0.0758	0.814	0.747	0.888	< 0.0001
> 70	–	–	–	–	–	–	–	–	0.418	0.357	0.490	< 0.0001
Race and ethnicity												
Caucasian (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Black	2.248	1.966	2.571	< 0.0001	2.632	2.106	3.288	0.0005	2.329	2.102	2.581	< 0.0001
Hispanic	1.899	1.565	2.302	0.0333	2.028	1.504	2.734	0.3883	1.362	1.181	1.569	0.6334
API	1.510	1.149	1.986	0.7090	1.890	1.260	2.833	0.8108	0.969	0.797	1.177	0.0002
Other/unknown	1.517	0.990	2.324	0.8218	1.946	1.053	3.595	0.7787	1.308	0.978	1.749	0.9357
Insurance												
Not Insured (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Private Insurance	0.329	0.256	0.422	< 0.0001	0.298	0.208	0.427	< 0.0001	0.469	0.388	0.566	< 0.0001
Medicaid	0.866	0.664	1.129	< 0.0001	0.749	0.511	1.097	0.0033	0.858	0.699	1.053	< 0.0001
Medicare	0.561	0.429	0.733	0.1256	0.381	0.256	0.567	0.0056	0.526	0.429	0.645	< 0.0001
Other Government	0.611	0.375	0.997	0.8800	0.501	0.228	1.103	0.8406	0.616	0.419	0.906	0.5849
Income												
Less than $38,000 (ref)	–	–	–	–	–	–	–	–	–	–	–	–
$38,000–$47,999	0.849	0.723	0.998	0.3503	0.740	0.572	0.957	0.8612	0.971	0.861	1.094	0.1277
$48,000–$62,999	0.769	0.654	0.904	0.2680	0.666	0.514	0.861	0.2427	0.880	0.781	0.993	0.1797
$63,000+	0.661	0.558	0.782	< 0.0001	0.574	0.440	0.748	0.0029	0.840	0.743	0.948	0.0061
Urban/rural												
Metropolitan (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Urban	0.588	0.476	0.725	0.0275	0.609	0.424	0.874	0.2223	0.877	0.770	1.000	0.2216
Rural	0.729	0.422	1.261	0.8587	0.752	0.298	1.899	0.9384	0.989	0.710	1.376	0.7489
Histology												
Mixed Carcinoma (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Ductal	0.797	0.453	1.402	0.2124	0.879	0.306	2.528	0.6715	1.167	0.669	2.036	0.3362
Lobular	1.095	0.470	2.548	0.5643	0.601	0.190	1.897	0.2132	1.027	0.580	1.817	0.7463
Grade												
Grade 1 (ref)	–	–	–	–	–	–	–	–	–	–	–	–

Table 5 (continued)

	Chemotherapy measure				Radiation therapy measure				Endocrine therapy measure			
	OR	95% CI		*p*-value	OR	95% CI		*p*-value	OR	95% CI		*p*-value
Grade 2	0.560	0.345	0.908	0.0905	1.458	1.089	1.952	0.0863	1.388	1.230	1.566	0.6106
Grade 3 and undifferentiated/anaplastic	0.502	0.315	0.802	0.0019	1.498	1.084	2.069	0.0697	1.846	1.623	2.100	< 0.0001
Surgery type												
Lumpectomy (ref)	–	–	–	–	–	–	–	–	–	–	–	–
Single mastectomy	1.819	1.589	2.083	0.3386	–	–	–	–	0.938	0.853	1.031	0.0002
Bilateral mastectomy	2.930	2.542	3.378	< 0.0001	–	–	–	–	1.251	1.130	1.386	< 0.0001
Tumor size (cm)												
< 1 (ref)	–	–	–	–	–	–	–	–	–	–	–	–
1.1–2.0	0.647	0.480	0.873	0.0047	1.255	0.980	1.607	0.0003	0.919	0.747	1.129	< 0.0001
2.1–3.0	0.595	0.440	0.806	< 0.0001	1.746	1.324	2.302	0.8708	1.199	0.973	1.477	0.3102
3.1–4.0	0.700	0.508	0.965	0.2616	1.871	1.282	2.730	0.7160	1.385	1.105	1.735	0.0591
4.1–5.0	0.693	0.478	1.006	0.3888	2.418	1.424	4.106	0.1437	1.477	1.141	1.911	0.0263
> 5	1.041	0.691	1.567	0.0142	3.152	1.665	5.967	0.0263	1.699	1.276	2.264	0.0006
Nodal status												
pN0 (ref)	–	–	–	–	–	–	–	–	–	–	–	–
pN1	0.995	0.874	1.132	0.6889	1.997	1.633	2.441	0.2715	2.087	1.922	2.267	0.2680
pN2	0.805	0.521	1.243	0.6157	2.615	1.786	3.830	0.0342	3.779	3.104	4.602	< 0.0001
pN3	0.714	0.524	0.973	0.2765	5.366	3.434	8.385	< 0.0001	3.351	2.847	3.945	< 0.0001
pNX	1.136	0.177	7.297	0.7787	0.414	0.085	2.013	0.0340	0.895	0.384	2.084	0.0313
Molecular marker status												
HER2+, HR+	–	–	–	–	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
HER2+, HR−	Ref	Ref	Ref	Ref	1.249	0.845	1.845	0.0028	–	–	–	–
HER2−, HR+	–	–	–	–	0.406	0.315	0.524	< 0.0001	0.297	0.272	0.323	< 0.0001
HER2−, HR−	0.854	0.753	0.969	0.0142	1.002	0.752	1.336	0.0583	–	–	–	–

Odds ratios by measure are shown, except for categories where the denominator of the measure does not apply. (For instance, if a measure is defined for women ≤ 70 years of age, those patients were removed from the subset and are not shown here.)

Table 6 The number of patients compliant with each measure

	Total	Overall		No transfer of care		Transfer of care		*p*-value
		N	%	*N*	%	*N*	%	
Chemotherapy	34,850	32,257	92.56	20,230	93.65	12,027	90.78	< 0.0001
Endocrine therapy	231,665	226,785	97.89	143,365	98.03	83,420	97.66	< 0.0001
Radiotherapy	253,612	252,686	99.63	163,879	99.68	88,807	99.56	< 0.0001

Institutions that are both high-volume and academic treat 42% of breast cancer patients in the United States [14]. While academic centers do show greater compliance with multiple breast-specific measures such as surgical margin status and appropriate administration of chemotherapy and radiotherapy, [14] we cannot confirm that institution type also correlates to improved efficiency as measures previously evaluated by institution type are not time-dependent. Because breast cancer is the most common malignancy in women [15] and participation in NAPBC and CoC accreditations are widespread, we are unlikely to see advocates recommend that breast surgeries be limited to a small number of high-volume institutions or those of a specific type [16] Consequently, greater efforts to comply with the standards may be required at institutions that see fewer patients with breast cancer.

Currently there is no standard for time to surgery [17, 18]. Although > 98% of breast cancer surgeries in the United States occur within 90 days, [2] we have found that TsOC increase the unadjusted time to surgery by one week. Although this 7.2 day delay will make no clinical difference in survival from their breast cancer, it does increase the likelihood that the time to surgery will be > 90 days by 73%. We are not aware of prior data evaluating this

Table 7 Compliance by threshold

	Total	90% threshold		100% threshold	
		Overall		Overall	
		Mean %	Median %	*n*	%
Chemotherapy	1310	92.55	95.79	524	40.00
Endocrine therapy	1327	97.48	98.28	287	21.63
Radiotherapy	1327	99.57	100.00	856	64.51

Setting a threshold of compliance for 90% (i.e., 90% of patients for the individual measure are compliant), displayed is the number of facilities that are compliant with each measure. With institutions being highly compliant at the patient level when the threshold is set at 90%, assessment was redone at the 100% level, recognizing that 100% compliance is rare for any measure

for breast cancer, but care transitions between institutions has been evaluated in bladder cancer, [19] where delays in the time to surgery also correlate with TsOC between institutions.

Perhaps the most important result of delays due to TsOC is the direct diminution of available time to begin chemotherapy and radiotherapy. While the overwhelming body of literature evaluates the effect of chemotherapy delays from the time of surgery and not diagnosis [20–30] the standard necessitates that chemotherapy be administered within 120 days of diagnosis, even when surgery is the first modality. With times to surgery more likely to be > 90 days, this leaves < 4 weeks to begin systemic therapy. We found that bilateral mastectomies, noted to be on the rise nationally [31] had the greatest odds of being > 90 days after diagnosis. Racial disparities [32] confirmed here even when adjusting for insurance, income, and urban–rural setting were still associated with longer times to treatment, but for reasons that remain unclear. With 24% of breast conservation patients requiring reoperation [33] and axillary node dissections performed at a second operation rather than at the same operation as sentinel lymphadenectomy (albeit less frequently) because of the American College of Surgeons Oncology Group Z0011 paradigm [34] obstacles to compliance have been increasing.

Our multivariable analysis found that further out from surgery, the less contribution there is to non-compliance by TsOC. In this study, we found that for a particular patient, TsOC conferred a 65.4% increase in the odds of non-compliance for chemotherapy, and a 56.5% and 25.6% rate for radiotherapy and endocrine therapy, respectively. The shorter delays seen between later modalities suggest that the bulk of the effect associated with TsOC is not on the transition between treatment modalities or due to specific patients' inability to quickly transition through the components of treatment. The time to surgery represents the bulk of the delay when assessing compliance of the measures, because these metrics measure from the time of diagnosis.

Although delays are detrimental, these data do not suggest that second opinions or TsOC should be prohibited or discouraged in breast cancer patients, but with transfers increasing, the effects on outcomes should be periodically reviewed at the national and facility levels. Individual institutions will need to assess their patterns of referral, and some may even consider methods to expedite patients whose time from diagnosis has been lengthy, such as for those who transfer care. Meanwhile, a strong argument could also be made from our data that these time-dependent standards should be refined to measure time from either surgery or the last modality administered, rather than from diagnosis. Published literature evaluating delay-related outcomes is indeed most often measured from surgery or the last treatment modality and not from diagnosis [35] as the current measures specify.

In short, TsOC between diagnosis and surgery increase the time to all treatment modalities, with the greatest effect seen on time to surgery, and smaller delays seen for those therapies further out from operation. Programs who receive large numbers of transferred patients after diagnosis should be aware of the potential impact on their quality measure compliance. Although high levels of compliance at this time indicate that the current standard definitions allow for such patterns of care, rising numbers of transfers may necessitate that institutions increasingly develop strategies to compensate for these delays. Simultaneously, consideration should be given to whether these standards should no longer measure from the time of diagnosis.

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Compliance with ethical standards

Conflict of interest All authors declare no conflicts of interest.

Ethical approval This research was comprised of de-identified database records of human participants, thus maintaining confidentiality and posing negligible or no risks to the participants within the dataset. This article does not contain any studies with animals performed by any of the authors.

Informed consent IRB review declared NCDB database review as exempt.

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