Med Oncol (2013) 30:419
DOI 10.1007/s12032-012-0419-1

ORIGINAL PAPER

Impact of timing of adjuvant chemotherapy initiation and completion after surgery on racial disparities in survival among women with breast cancer

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Received: 5 November 2012 / Accepted: 9 November 2012 / Published online: 6 January 2013

Abstract While large differences by race/ethnicity in breast cancer survival are well established, it is unknown whether differences in quality of chemotherapy delivered explain the racial/ethnic disparities in survival among black, Hispanic, Asian, and white women with breast cancer. We evaluated factors associated with time to initiation of adjuvant chemotherapy and chemotherapy completion and examined outcomes data among women with breast cancer. Patients who initiated chemotherapy later than 3 months after surgery were 1.8 times more likely to die of breast cancer (95 % CI 1.3–2.5) compared with those who initiated chemotherapy less than a month after surgery, even after controlling for known confounders or controlling for race/ethnicity. Women who completed chemotherapy had significantly higher survival compared with those who have not completed chemotherapy. Despite correcting for chemotherapy initiation and completion and known predictors of outcome, African American women still had worse disease-specific survival than their Caucasian counterparts. While a complete and timely adjuvant treatment among various ethnic populations would help to reduce racial disparities in survival, there are still other factors to be identified that may explain the remaining differences in survival between ethnic women with breast cancer.

Keywords Breast cancer · Chemotherapy · Delay · SEER–Medicare · Survival · Health disparities

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Introduction

Effect of chemotherapy treatment quality on survival of breast cancer patients of diverse racial/ethnic background has not been well addressed in population-based cohort studies [1, 2]. A recent national cohort study reported delays in adjuvant chemotherapy treatment among patients with breast cancer among African American and Hispanic populations compared with whites [3]. Based on the study of patients enrolled onto Southwest Oncology Group adjuvant breast cancer trials, African American women are more likely to experience both early discontinuation and treatment delay compared with their Caucasian counterparts. Less is known about the effect of chemotherapy delay on survival in non-white older women with breast cancer with a higher comorbidity profile. Moreover, there is a dearth of information on the impact of chemotherapy completion for breast cancer on long-term outcomes among women of diverse racial/ethnic background. Because the majority of breast cancer diagnoses occur after age 65 and increased life expectancy and advances in treatment will increase the number of breast cancer survivors [4–8], we examined the impact of treatment quality on survival among white, black, Hispanic, and Asian Medicare part A and B enrollees diagnosed between 1992 and 2005 with stages I–III BC.

Patients and methods

Database and study participants

This study employed a database codeveloped by the US National Cancer Institute (NCI) and the Center for Medicare and Medicaid Services (CMS). The surveillance, epidemiology and end-results (SEER) program, sponsored by NCI, is a network of tumor registries covering roughly 14 % of the United States population before 1999 and 26 % of the US populations after 2000. The CMS's Medicare program covers hospital services, physician services, some drug therapy, and other medical services for more than 97 % of persons aged 65 and older. The SEER–Medicare dataset is a unique population-based resource for longitudinal epidemiologic studies; it is well validated and has been described comprehensively elsewhere [14, 15]. We included women, aged 65 years and older, who were diagnosed with stage I or III breast cancer from 1991 to 2005 and initiated chemotherapy within 12 months of their diagnosis. We excluded women who did not participate in both Medicare Part A and Part B from 12 months prior to their diagnosis; patients who received radiation therapy prior to chemotherapy; and women who had a prior cancer diagnosed before age 65, a prior breast cancer or other cancer, end-stage renal disease or a diagnosis without histological confirmation.

Measurement of treatment and outcomes

Surgery, chemotherapy and radiation receipt were ascertained using linked SEER–Medicare databases as previously described [9–15]. The definitive surgical procedure at the primary site captured the most invasive surgical procedure at the primary site to categorize breast cancer patients as having had mastectomy or BCT (breast-conservation therapy) within 6 months after the breast cancer diagnosis. Chemotherapy administration was ascertained from the Medicare files using ICD-9-Cm diagnosis and procedure codes, CPT, HCPCS, and revenue center codes. Time to adjuvant chemotherapy was defined by the days from the most definitive resection of the primary site to the first administration of chemotherapy. The date of chemotherapy initiation was determined from the date of first chemotherapy claim. Delay in chemotherapy was defined as a time interval of greater than 3 months after chemotherapy was following definitive surgery [2]. The length of chemotherapy was measured as the number of months between the first and last claims indicating the use of chemotherapy. The standard length of adjuvant chemotherapy administered to breast cancer patients usually does not exceed 24 weeks [16]. Complete adjuvant chemotherapy was defined as 6 months of chemotherapy. To avoid misclassifying chemotherapy for cancer recurrence as adjuvant therapy, only chemotherapy administered within a designated treatment period was taken into account as previously described [16]. Survival was calculated as the number of months between the date of diagnosis and the date of death. Patients who were lost to follow-up or who survived beyond December 31, 2005, were coded as censored observations. The day of diagnosis was defined as the 15th of the month, because SEER only reports the month and year of diagnosis. The survival end points for the present study were overall survival (OS) and disease-specific survival (DSS).

Analyses

Kaplan–Meier survival curves were compared by log-rank test. We compared the differences in categorical variables and proportions between black, Hispanic, Asian, and white women diagnosed with breast cancer by χ^2 testing. We also performed univariate analyses to determine the influence of potential patient, tumor, and treatment prognostic factors on OS and DSS determined by the Kaplan–Meier method. Variables in univariate analysis included: age, socioeconomic status (proportion of census tract below poverty in quartiles, with the first quartile denoting high SES), comorbidity index [17–21], tumor grade (low/intermediate vs. high), tumor size (T1–T3), estrogen receptor (ER) and progesterone receptor (PR) status (positive, negative, unknown), use of radiotherapy after surgery (yes vs. no), year of diagnosis, chemotherapy initiation (less than a month, less than 2 months, less than 3 months, and more than 3 months), chemotherapy completion (yes, no). Significant factors from the univariate analysis were included in a multivariate Cox proportional hazard model to identify significant predictors of OS and DSS. Hazard ratios (HRs) and 95 % confidence intervals (CIs) were obtained for all regressions. Analyses were performed using SAS release 9.2 (SAS Institute Inc., Cary, North Carolina). All tests were two-tailed with statistical significance set at $P < 0.05$.

Results

We identified 14,380 women diagnosed with stages I–III between January 1, 1992 and December 31, 2005. Table 1 displays patient and tumor characteristics by race/ethnicity. African American and Hispanic patients were disproportionately residing in areas with lower socioeconomic status (SES) compared with white patients. On average, white patients tended to be older than non-white patients. Higher Charlson–Deyo comorbidity scores and more advanced disease stages were more common among African American and Hispanic patients compared with all other ethnic

Table 1 Demographic and tumor characteristics of men and women diagnosed with AJCC stages I, II, and III breast cancer from 1992 to 2005, by race/ethnicity (percent)

	Non-Hispanic White ($n = 12, 231$)		Non-Hispanic Black ($n = 579$)		Hispanic ($n = 1,012$)		Asian/Pacific Islander ($n = 558$)	
	n	%	*n*	%	*n*	%	*n*	%
Characteristic								
Age (years)								
66–69	3,935	32.17	205	35.41	345	34.09	194	34.77
70–74	4,156	33.98	211	36.44	339	33.50	210	37.63
75–79	2,720	22.24	109	18.83	220	21.74	106	19.00
80–89[a]	1,420	11.63	54	9.32	106	10.67	48	8.60
Marital status								
Married	6,368	52.06	271	46.80	311	30.73	320	57.35
Unmarried[b]	5,863	47.94	308	53.20	701	69.27	238	42.66
Percent in census tract living in poverty								
First quartile, high	4,867	39.79	108	18.65	206	20.36	175	31.36
Second quartile	2,752	22.50	72	12.44	78	7.71	111	19.89
Third quartile	2,575	21.05	102	17.62	171	16.90	153	27.42
Fourth quartile, low	2,037	16.65	297	51.30	557	55.04	119	21.33
Tumor stage (AJCC)								
I	4,606	37.64	190	32.82	267	26.38	214	38.35
II	6,868	56.15	347	59.93	642	63.44	310	55.56
III	759	6.21	42	7.25	103	10.18	34	6.09
Tumor size (cm)								
<1.0	1,610	13.16	60	10.36	108	10.67	94	16.85
1.0–<2.0	4,508	36.86	179	30.92	253	25.00	196	35.13
2.0–<5.0	5,185	42.39	291	50.26	519	51.28	221	39.61
≥5.0	928	7.59	49	8.46	132	13.04	47	8.42
Tumor grade								
Well differentiated	1,617	13.95	61	10.76	100	10.06	88	16.12
Moderately/poorly differentiated	8,935	74.57	428	75.49	777	78.17	414	75.82
Unknown	1,376	11.48	78	13.76	117	11.77	44	8.06
Comorbidity score								
0	4,946	70.01	215	62.50	349	57.03	219	67.38
1	1,499	21.22	92	26.74	179	29.25	71	21.85
2+	620	8.78	37	10.76	84	13.73	35	10.77
Lymph nodes positive								
0	6,987	57.13	315	54.40	494	48.81	314	56.27
1	1,791	14.64	76	13.13	174	17.19	75	13.44
2–3	1,376	11.25	67	11.57	133	13.14	63	11.29
4–5	655	5.36	41	7.08	63	6.23	35	6.27
6–9	672	5.49	44	7.60	66	6.52	33	5.91
10–51	750	6.13	36	6.22	82	8.10	38	6.81
Radiation								
No[c]	7,052	57.66	353	60.97	655	64.53	305	53.76
Yes	5,179	42.34	226	39.03	359	35.47	258	46.24
Urban/rural residence								
Big metropolitan	6,783	55.46	360	62.18	790	78.06	234	41.94
Metropolitan	3,386	27.68	153	26.42	154	15.22	259	46.42
Urban or less urban[d]	2,062	16.86	66	11.40	67	6.72	65	11.64

Table 1 continued

	Non-Hispanic White ($n = 12, 231$)		Non-Hispanic Black ($n = 579$)		Hispanic ($n = 1,012$)		Asian/Pacific Islander ($n = 558$)	
	n	%	*n*	%	*n*	%	*n*	%
Year of diagnosis								
1992	636	5.20	26	4.49	52	5.14	15	2.69
1993	590	4.82	21	3.63	45	4.45	20	
1994	587	4.80	32	5.53	43	4.25	22	3.94
1995	606	4.95	34	5.87	43	4.25	27	4.84
1996	586	4.79	26	4.49	46	4.55	26	4.66
1997	670	5.48	29	5.01	40	3.95	37	6.63
1998	682	5.58	27	4.66	56	5.53	40	7.17
1999	750	6.13	39	6.74	73	7.21	42	7.53
2000	1,488	12.17	80	13.82	102	1008	50	8.96
2001	1,561	12.76	73	12.61	124	12.25	62	11.11
2002	1,474	12.05	66	11.40	127	12.55	58	10.39
2003	897	7.33	54	9.33	92	9.09	58	10.39
2004	898	7.34	46	7.94	87	8.60	56	10.04
2005	806	6.59	26	4.49	82	8.10	45	8.06

[a] Age category 80–84 was combined with 85–89; [b] Category "Unmarried" was combined with "Unknown;" [c] Category "No" was combined with "Unknown;" [d] Category "Urban" was combined with "Less urban" because the SEER–Medicare data user agreement requires all cells of $N < 11$ not to be reported

groups. African American and Hispanic patients were also more likely to have tumor size >2 cm, larger number of positive lymph nodes, and higher proportions of moderately/poorly differentiated tumors compared with whites.

Slightly higher proportions of patients of African American descent and Hispanic origin were likely to have more than 3 months delay in chemotherapy initiation compared with whites (Table 2). Whites were more likely to complete adjuvant chemotherapy compared with non-whites. Patients who initiated chemotherapy in more than 3 months after surgery were 1.83 times more likely to die of breast cancer (95 % CI 1.31–2.47) compared with those who initiated chemotherapy earlier after correcting for known predictors of outcome (Table 3). Survival was significantly worse for patients who initiated chemotherapy in more than 3 months compared with those who did so in less than a month regardless of race/ethnicity and other factors. Women who completed chemotherapy had significantly higher survival compared with those who have not completed chemotherapy (60–64 % vs. 35–39 % for all ethnic groups) (Table 2).

Tables 4 and 5 show the clinical and pathological factors affecting OS and DSS. Patients of Asian descent had better OS and DSS compared with whites after adjusting for selected covariates. Older, unmarried women, those with poorly differentiated and larger tumors, negative ER status, or higher comorbidity scores had reduced OS. Adjusting for time to initiation and completion of chemotherapy did not affect racial/ethnic disparities in OS. Patients of African American descent, those who were older or who had poorly differentiated and larger tumors, with negative ER status, and higher comorbidity scores had reduced DSS. Despite correcting for chemotherapy initiation and completion and other known confounders, African American women still had worse survival than their Caucasian counterparts.

Discussion

These data are unique in that they are one of the first reports on the impact of both treatment delay and completion of chemotherapy on health outcomes in a population-based cohort of older Caucasian, African American, Hispanic, and Asian women with breast cancer. Similar to what was reported by Fedewa and colleagues [3], our findings show statistically significant differences in time to chemotherapy initiation after surgery for African American and Hispanic women with breast cancer compared with white women. Consistent with the findings from another study [2], we found that white women completed adjuvant chemotherapy more frequently compared with non-whites. Older age at diagnosis, treatment toxicity, treatment complications, disease progression, and comorbidities was mentioned among reasons for early discontinuation of treatment and/or treatment delay [22]. Hershman et al. [2]

Table 2 Comparison of initiation and completion chemotherapy among different racial/ethnic groups in women with AJCC stages I, II, and III breast cancer from 1992 to 2005

	Non-Hispanic White ($n = 12, 231$)		Non-Hispanic Black ($n = 579$)		Hispanic ($n = 1,012$)		Asian/Pacific Islander ($n = 558$)	
	n	%	*n*	%	*n*	%	*n*	%
Interval from surgery to chemotherapy								
Less than a month	2,839	23.2	133	23.0	202	19.9	106	19.0
Less than two months	5,937	48.5	274	47.3	467	46.2	304	54.3
Less than three months	2,075	17.0	104	18.0	210	20.8	97	17.4
More than three months (delay)	1,380	11.3	68	11.7	133	13.1	51	9.3
Chemotherapy completion								
No	4,354	35.6	218	37.7	365	36.1	221	39.7
Yes	7,877	64.4	361	62.3	647	63.9	337	60.3

Table 3 Association between survival and chemotherapy initiation/completion among different racial/ethnic groups in women with AJCC stages I, II, and III breast cancer from 1992 to 2005

	Hazard ratio (95 % confidence interval)			
	Overall survival		Breast cancer-specific survival	
	Model 1	Model 2	Model 3	Model 4
Interval from surgery to chemotherapy				
Less than a month	1.00	1.00	1.00	1.00
Less than 2 months	0.95 (0.81–1.10)	0.95 (0.82–1.10)	0.98 (0.78–1.22)	0.98 (0.78–1.22)
Less than 3 months	1.02 (0.84–1.20)	1.01 (0.84–1.23)	1.00 (0.75–1.33)	1.00 (0.75–1.32)
More than 3 months (delay)	**1.56 (1.33–1.82)**	**1.53 (1.32–1.80)**	**1.85 (1.33–2.49)**	**1.83 (1.31–2.47)**
Chemotherapy completion				
No	1.00	1.00	1.00	1.00
Yes	0.81 (0.74–0.89)	0.81 (0.74–0.89)	0.75 (0.67–0.84)	0.75 (0.66–0.84)

*Models 1 and 3: Hazard ratio of mortality was adjusted for age, marriage status, tumor stage, size, grade, hormone receptor status, comorbidity, year of diagnosis, SEER region, primary surgery and radiotherapy, and chemotherapy. Models 2 and 4: Hazard ratio of mortality was adjusted for race/ethnicity, in addition to above factors

Bold denotes statistical significance

reported that for African American women, early discontinuation and/or treatment delay was explained by an increase in missed appointments

In our study, inferior survival associated with receiving adjuvant chemotherapy more than 3 months after definitive surgery persisted after controlling for known prognostic factors. This is consistent with the data reported by Lohrisch et al. [23] who showed that survival is compromised by chemotherapy delays of more than 12 weeks after definitive surgery. Significant differences in chemotherapy completion in African American and Hispanic women compared with whites did not eliminate disparities in survival among these racial/ethnic groups. Hershman and colleagues [2] also noted persistent disparities in survival between African American and white women after adjusting for known predictors of survival and treatment quality in a data obtained from clinical trials. One possible explanation may involve differential rates of adherence to hormonal therapy. African American women may be less likely to complete a full 5-year course of adjuvant hormonal therapy and clinical trials do not usually measure hormonal therapy adherence [24]. In addition, racial or ethnic differences in genes responsible for the metabolism of either chemotherapeutic agents or hormonal treatments may contribute to these findings, and this variability may affect both toxicity and effectiveness of the treatment [25, 26]. It is known that African American women with breast cancer, especially those who are premenopausal, seem to have a higher incidence of biologically more aggressive cancers that are basal-like or triple negative [27–29]. One of the earlier studies by Hershman et al. using SEER–Medicare data on women diagnosed with breast cancer between 1992 and 1999 with stages I–II BC did not reveal differences in chemotherapy initiation between

Table 4 Associations between breast cancer-specific survival, race/ethnicity and chemotherapy initiation, or completion in women with breast cancer who underwent surgery, 1992–2005

	Model 1		Model 2		Model 3	
	HR	95 % CI	HR	95 % CI	HR	95 % CI
Race/ethnicity						
Whites	1.00	Reference	1.00	Reference	1.00	Reference
Hispanics	0.86	0.63–1.17	0.85	0.63–1.15	0.83	0.61–1.13
African Americans	**1.32**	**1.07–1.61**	**1.25**	**1.02–1.53**	**1.24**	**1.01–1.52**
Asians/Pacific Islanders	**0.63**	**0.43–0.91**	**0.64**	**0.44–0.93**	**0.63**	**0.43–0.91**
Age at diagnosis, years						
65–69	1.00	Reference	1.00	Reference	1.00	Reference
70–74	1.24	1.06–1.44	1.08	0.93–1.26	1.09	0.93–1.27
75–79	1.71	1.46–2.01	1.38	1.17–1.63	1.39	1.18–1.64
80–84	1.95	1.60–2.39	1.40	1.14–1.71	1.40	1.14–1.72
85+	2.43	1.78–3.32	1.51	1.10–2.08	1.52	1.11–2.09
Marital status						
Unmarried	1.00	Reference	1.00	Reference	1.00	Reference
Married	1.14	1.01–1.29	1.10	0.97–1.24	1.10	0.98–1.25
Tumor stage						
I	1.00	Reference	1.00	Reference	1.00	Reference
II	1.92	1.39–2.66	2.17	1.57–3.00	2.17	1.57–3.00
IIIA	4.04	2.96–5.50	4.949	3.63–6.76	4.932	3.61–6.73
Tumor grade						
Well/moderately differentiated	1.00	Reference	1.00	Reference	1.00	Reference
Poorly	2.16	1.68–2.77	2.282	1.78–2.93	2.24	1.75–2.87
Unknown	2.13	1.59–2.84	2.112	1.58–2.82	2.10	1.57–2.81
Estrogen receptor status						
Positive	1.00	Reference	1.00	Reference	1.00	Reference
Negative	1.51	1.33–1.71	1.86	1.64–2.11	1.86	1.64–2.11
Comorbidity						
0	1.00	Reference	1.00	Reference	1.00	Reference
1	1.62	1.24–2.12	1.60	1.22–2.10	1.64	1.25–2.14
2+	1.73	1.57–2.93	1.78	1.61–3.00	1.77	1.60–2.98
Histology						
Ductal	1.00	Reference	1.00	Reference	1.00	Reference
Ductal–lobular	0.89	0.69–1.12	0.88	0.69–1.12	0.85	0.67–1.08
Lobular	0.72	0.58–0.89	0.739	0.60–0.91	0.74	0.60–0.91
Mucinous	0.42	0.22–0.82	0.361	0.19–0.70	0.35	0.18–0.69
Tubular	0.47	0.24–0.96	0.440	0.22–0.89	0.47	0.23–0.95
Chemotherapy delay						
No	–	–	1.00	Reference	1.00	Reference
Yes	–	–	**1.88**	**1.54–3.26**	**2.00**	**1.64–2.40**
Chemotherapy completion						
No	–	–	–	–	1.00	Reference
Yes	–	–	–	–	**0.66**	**0.58–0.74**

Bold denotes statistical significance

African–American and Caucasian women. Differences in the findings of the two studies are likely due to our inclusion of women with a more advanced disease stage.

This study has several limitations as previously described [13]. Our analysis did not include beneficiaries enrolled in HMOs. Hispanic women are more likely to be in

Table 5 Associations between overall survival, race/ethnicity and chemotherapy initiation or completion in women with breast cancer who underwent surgery, 1992–2005

	Model 1		Model 2		Model 3	
	HR	95 % CI	HR	95 % CI	HR	95 % CI
Race/ethnicity						
Whites	1.00	Reference	1.00	Reference	1.00	Reference
Hispanics	0.90	0.72–1.12	0.89	0.71–1.11	0.87	0.70–1.09
African American	1.16	1.00–1.36	1.13	0.96–1.32	1.12	0.96–1.31
Asians/Pacific Islanders	**0.67**	**0.52–0.87**	**0.68**	**0.52–0.88**	**0.67**	**0.52–0.88**
Age at diagnosis, years						
65–69	1.00	Reference	1.00	Reference	1.00	Reference
70–74	1.34	1.21–1.53	1.27	1.13–1.43	1.27	1.13–1.43
75–79	1.94	1.72–2.19	1.73	1.53–1.96	1.74	1.53–1.96
80–84	2.58	2.24–2.98	2.14	1.85–2.48	2.15	1.86–2.49
85+	3.58	2.91–4.40	2.72	2.21–3.36	2.74	2.22–3.38
Marital status						
Unmarried	1.00	Reference	1.00	Reference	1.00	Reference
Married	1.25	1.14–1.36	1.22	1.12–1.33	1.22	1.12–1.34
Tumor stage						
I	1.00	Reference	1.00	Reference	1.00	Reference
II	1.33	1.11–1.59	1.42	1.19–1.70	1.42	1.19–1.70
IIIA	2.038	1.72–2.42	2.28	1.92–2.71	2.27	1.91–2.70
Tumor grade						
Well/moderately differentiated	1.00	Reference	1.00	Reference	1.00	Reference
Poorly	1.44	1.24–1.67	1.48	1.27–1.72	1.47	1.26–1.70
Unknown	1.67	1.40–2.00	1.661	1.39–1.99	1.66	1.39–1.99
Estrogen receptor status						
Positive	1.00	Reference	1.00	Reference	1.00	Reference
Negative	1.31	1.19–1.44	1.48	1.34–1.63	1.47	1.34–1.62
Comorbidity						
0	1.00	Reference	1.00	Reference	1.00	Reference
1	1.83	1.51–2.22	1.85	1.53–2.24	1.87	1.55–2.27
2+	1.88	1.74–2.05	1.92	1.77–2.10	1.91	1.76–2.08
Histology						
Ductal	1.00	Reference	1.00	Reference	1.00	Reference
Ductal–lobular	0.92	0.77–1.09	0.92	0.77–1.09	0.90	0.75–1.07
Lobular	0.81	0.70–0.94	0.82	0.71–0.95	0.82	0.70–0.95
Mucinous	0.65	0.45–0.93	0.60	0.42–0.86	0.59	0.41–0.84
Tubular	0.40	0.23–0.71	0.39	0.22–0.70	0.41	0.22–0.72
Chemotherapy delay						
No	–	–	1.00	Reference	1.00	Reference
Yes	–	–	**1.80**	**1.64–1.97**	**1.86**	**1.69–2.03**
Chemotherapy completion						
No	–	–	–	–	1.00	Reference
Yes	–	–	–	–	**0.75**	**0.69–0.82**

Model 1 was additionally adjusted for socioeconomic status, radiotherapy

Bold denotes statistical significance

Medicare HMOs (because of the residence area) [30]. Both Hispanic and African American women enrolled in traditional Medicare (i.e., not enrolled in HMOs) are less likely than white women to have supplemental coverage, and are more likely to have Medicaid [30]. This might lead to a selection bias if there are systematic differences, disease or

treatment characteristics, between HMO enrollees and non-enrollees. Comparisons of the accuracy of Medicare's race codes with self-report (using the Medicare Current Beneficiary Survey data) suggested that the primary error is in mistakenly identifying some Asians, Native Americans, and Hispanics as white [31]. The impact of the misclassification has not been examined to date. Because patient comorbidity is identified from diagnoses coded on claim forms, breast cancer survivors may have greater interaction with care providers that could have led to more comorbid conditions identified. Furthermore, income, supplemental insurance, and availability of providers all significantly affect access to care but were not included in our models which only included a census tract SES variable on the percentage of persons living in poverty and urban–rural status.

In summary, this study clarified some of the effects of chemotherapy delivery on survival by race/ethnicity among older BC survivors with Medicare coverage. Delay in chemotherapy initiation and lack of chemotherapy completion were significantly associated with a decreased survival. African American women still had worse survival even after controlling for chemotherapy initiation and chemotherapy completion. The findings have important clinical implications for both care providers and patients in timely chemotherapy initiation and complete cycles of chemotherapy. A better understanding of the barriers to complete and timely adjuvant treatment among various ethnic populations would help to reduce racial disparities in survival, while realizing that there are still other factors to be identified that may explain the remaining differences in survival between ethnic women with breast cancer [32, 33].

Acknowledgments This work was supported by "A Transdisciplinary Training Program for Public Health Researcher & Practitioners wanting to Impact Breast Cancer Disparities" KG090010 Susan G. Komen Breast Cancer Foundation; and in part by a grant from the Agency for Healthcare Research and Quality [R01-HS018956].

Conflict of interest The authors have declared no conflicts of interest.

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