Original Article

Emerging Trends in Surgical and Adjuvant Radiation Therapies Among Women Diagnosed With Ductal Carcinoma In Situ

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BACKGROUND: The use of surgery and radiation therapy in treating ductal carcinoma in situ (DCIS) is directed by treatment guidelines and evidence from research. This study investigated recent patterns in DCIS treatment by demographic factors. **METHODS:** Data for women diagnosed with DCIS between 1998 and 2011 (n = 416,232) in the National Cancer Data Base were assessed for trends in treatment patterns by age group, calendar year, ancestral/ethnic group, and geographic region. The likelihood of receiving specific treatment modalities was analyzed with multivariable logistic regression. **RESULTS:** DCIS cases were most frequently treated with breast-conserving surgery (BCS) and adjuvant radiation (45.6%). After an initial rise, the use of adjuvant radiation after BCS plateaued at approximately 70% after 2007, with increasing utilization of mastectomy beyond 2005. In addition, there was an increasing trend in postmastectomy reconstruction over time, and women of African ancestry (odds ratio [OR], 0.69; 95% confidence interval [CI], 0.66-0.72) and Hispanic women (OR, 0.83; 95% CI, 0.78-0.89) were less likely to undergo reconstruction in comparison with women of European ancestry. A similar trend was observed in contralateral risk-reducing mastectomy utilization, with women of European ancestry having a more rapid rise in the utilization of contralateral risk-reducing mastectomy in comparison with all other ancestral/ethnic groups. **CONCLUSIONS:** Recent trends demonstrate a plateau in radiation therapy administration after BCS along with increasing utilization of mastectomy, reconstruction, and contralateral risk-reducing mastectomy. There are substantial differences in treatment utilization according to ancestry/ethnicity and geographical region. Further studies examining patient-physician decision making surrounding DCIS treatment are warranted. ***Cancer*** **2016;122:2810–8**. © *2016 American Cancer Society.*

KEYWORDS: breast cancer, ductal carcinoma in situ, mastectomy, radiation, reconstruction.

INTRODUCTION

Ductal carcinoma in situ (DCIS) is a pre-invasive breast lesion, with 1 woman diagnosed with DCIS for every 4 women diagnosed with invasive breast cancer.[1] Before routine mammography, DCIS lesions accounted for less than 5% of breast cancer cases.[2] However, widespread screening mammography caused a rise in the detection of DCIS lesions.[3] The incidence of DCIS in the United States increased from 1.87 per 100,000 women in 1973-1975 to 32.5 in 2004.[4]

Various treatment options to lower the risk of recurrence and prevent invasive breast cancer are available for patients with DCIS. The DCIS 5-year mortality rate is <2%.[5] Surgical excision with or without adjuvant therapy is the primary approach for DCIS treatment. Surgical options include breast-conserving surgery (BCS) with or without radiotherapy and mastectomy.[2,6] Adjuvant tamoxifen may also be used among women with estrogen receptor–positive disease.[7]

Variations in the utilization of treatment modalities for DCIS treatment likely result in undertreatment in some cases or overly aggressive surgical therapy in others.[8,9] Avoidance of adjuvant radiation therapy after BCS may increase the

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See editorial on pages 2780-2, this issue.

We thank Julie McGregor, Kathy Peck, Laura Stephenson, Berta Geller, Dawn Pelkey, Kathleen Howe, and John Mace for study support and data collection. In addition, we thank Caprice Greenberg, MD, MPH, for her suggestions while the manuscript was being prepared.

All data used in this analysis were deidentified and were derived from the National Cancer Data Base. The authors bear sole responsibility for the reporting and interpretation of the analyzed data. The American College of Surgeons and the Commission on Cancer have not verified and are not responsible for the analytical or statistical methodology used or the conclusions drawn from these data by the authors.

DOI: 10.1002/cncr.30105, **Received:** January 21, 2016; **Revised:** March 10, 2016; **Accepted:** March 14, 2016, **Published online** May 31, 2016 in Wiley Online Library (wileyonlinelibrary.com)

utilization of mastectomy despite the lack of an overall survival benefit.[10,11] Geographic and temporal variations have been observed in the treatment of DCIS, with the Midwest and South-Central states having higher rates of mastectomies than the Northeastern states.[8] Breast reconstruction after mastectomy is associated with geographical/regional location, institutional practice pattern, age, and race/ethnicity.[8,10]

The utilization of contralateral mastectomy (ie, surgical removal of the uninvolved breast), particularly among high-risk women, is controversial. Factors associated with contralateral mastectomy include the following: younger age, family history, genetic predisposition, tumor size, and higher grade.[12,13]

Given the historical variation in the treatment of DCIS, we sought to examine recent trends, including the association of demographic factors with local DCIS treatment, with the National Cancer Data Base (NCDB).

MATERIALS AND METHODS

Study Population

The NCDB is a joint project of the Commission on Cancer of the American College of Surgeons and the American Cancer Society. More than 1500 cancer care institutions contribute data to the NCDB, which includes 70% of all newly diagnosed cancers in the United States. Further details about the NCDB have been reported elsewhere.[14,15] We obtained data from the NCDB for women who were 20 years old or older and diagnosed with DCIS between 1998 and 2011. The study was approved by the University of Wisconsin–Madison institutional review board. Women diagnosed with DCIS were identified with the third edition of *International Classification of Diseases for Oncology* (behavior code 2 and morphology codes 8050, 8201, 8210, 8230, 8401, 8500, 8501, 8503, 8504, 8507, 8522, 8523, 8540, and 8543), and they were coded as stage 0 according to the American Joint Committee on Cancer guidelines (seventh edition).[16,17] A total of 434,695 cases met these criteria. Patients who had no treatment data (n = 4248), had undergone an unspecified type of mastectomy with no information on the receipt of reconstruction or contralateral mastectomy (n = 1562), had undergone extended radical mastectomy (n = 87), or did not receive any treatment (n = 12,566) were excluded.

Variables of Interest

Treatments were categorized as BCS, BCS with radiation, and mastectomy (ie, total mastectomy). Women undergoing mastectomy were subclassified according to whether they had received contralateral mastectomy and/or breast reconstruction. Ancestry/ethnicity was classified as non-Hispanic European, non-Hispanic African, Hispanic, or other. The region of residence was categorized as Northeast, Midwest, West, or South. The facility type was classified as a community cancer program, comprehensive community cancer program, academic/research program (including National Cancer Institute–designated comprehensive cancer centers), or other. Treatment facilities were divided into patient volume tertiles based on the number of women treated for DCIS.

TABLE 1. Characteristics of Women Diagnosed With Ductal Carcinoma In Situ in the National Cancer Data Base, 1998-2011

Characteristic	No.	%
Total	416,232	
Age group		
<45 y	47,561	11.4
45–54 y	108,907	26.2
55–64 y	109,767	26.4
65–74 y	89,712	21.5
≥75 y	60,285	14.5
Year of diagnosis		
1998–1999	48,002	11.5
2000–2001	54,101	13.0
2002–2003	56,418	13.5
2004–2005	56,421	13.6
2006–2007	61,994	14.9
2008–2009	70,605	17.0
2010–2011	68,691	16.5
Ancestry/ethnicity		
Non-Hispanic European	334,757	80.4
Non-Hispanic African	42,648	10.2
Hispanic	16,354	3.9
Other	22,473	5.4
Geographic region		
Northeast	103,564	25.0
Midwest	102,289	24.5
South	139,354	33.5
West	71,025	17.0
Health insurance		
Private	250,004	60.1
Government	151,069	36.3
Uninsured	6,173	1.5
Unknown	8,986	2.2
Primary treatment		
Breast-conserving surgery without adjuvant radiation	95,076	22.8
Breast-conserving surgery with adjuvant radiation	189,847	45.6
Mastectomy	131,309	31.5
Adjuvant endocrine therapy		
Yes	120,607	29.0
No	270,859	65.1
Unknown	24,766	5.9
Facility type		
Community cancer program	40,832	9.8
Comprehensive community cancer program	247,915	59.5
Academic/research program	118,025	28.4
Other specified types of cancer programs	9,460	2.3

TABLE 2. Demographics of BCS Among Women Diagnosed With Ductal Carcinoma In Situ in the National Cancer Data Base, 1998-2011

Variable	Mastectomy (n = 131,309), % by Row	BCS (n = 284,923), % by Row	OR (95% CI)[a]
Age group			
<45 y	43.5	56.5	1
45-54 y	32.9	67.1	1.60 (1.54-1.65)
55-64 y	29.2	70.8	1.92 (1.85-1.99)
65-74 y	28.4	71.6	2.14 (2.05-2.23)
≥75 y	28.6	71.4	2.11 (2.02-2.21)
Year of diagnosis			
1998-1999	33.4	66.6	1
2000-2001	31.9	68.1	1.12 (1.08-1.16)
2002-2003	29.9	70.1	1.21 (1.15-1.26)
2004-2005	29.3	70.7	1.21 (1.13-1.29)
2006-2007	30.2	69.8	1.23 (1.16-1.31)
2008-2009	32.8	67.2	1.12 (1.05-1.19)
2010-2011	33.1	66.9	1.12 (1.05-1.20)
Ancestry/ethnicity			
Non-Hispanic European	31.4	68.6	1
Non-Hispanic African	32.2	67.8	1.05 (1.01-1.08)
Hispanic	31.6	68.4	1.14 (1.08-1.21)
Other	32.3	67.7	1.00 (0.94-1.06)
Geographic region			
Northeast	25.9	74.1	1
Midwest	31.7	68.3	0.75 (0.73-0.77)
South	35.2	64.8	0.64 (0.62-0.66)
West	32.4	67.6	0.70 (0.68-0.73)

Abbreviations: BCS, breast-conserving surgery; CI, confidence interval; OR, odds ratio.
For the test of interaction between the year of diagnosis and ancestry/ethnicity, χ^2 was 42.70, the degrees of freedom were 18, and *P* was <.01.
[a] Adjusted for the comorbidity index, health insurance, facility type, facility ductal carcinoma in situ patient volume, and tumor size and grade.

Statistical Analysis

We estimated the odds ratios (ORs) and 95% confidence intervals (CIs) of receiving adjuvant radiation therapy after BCS and the utilization of BCS (with or without radiation therapy) versus mastectomy with multivariable logistic regression models. In addition, we evaluated breast reconstruction after mastectomy and contralateral breast removal after therapeutic mastectomy. In all models, covariates included the age of diagnosis, ancestry/ethnicity, year of diagnosis, and geographic region. We also adjusted for comorbidities, health insurance, tumor size and grade, treatment facility, and institutional volume. Two-sided *P* values $< .05$ were considered to be statistically significant. Interactions between ancestry/ethnicity and the year of diagnosis were examined. Age-adjusted rates of surgeries after therapeutic mastectomy (ie, breast reconstruction and contralateral risk-reducing mastectomy) by ancestral/ethnic groups were calculated with the 2000 US standard million population.[18] Analyses were performed with SAS (version 9.3).

RESULTS

We identified 416,232 women diagnosed with DCIS between 1998 and 2011 (Table 1). Women in the 45- to 54-year and 55- to 64-year age groups accounted for most cases (>26% each). Most cases were women of non-Hispanic European ancestry (80.4%). More than 95% had health insurance; 46% were treated with adjuvant radiation therapy, and 29% received adjuvant endocrine therapy.

BCS and Mastectomy

Women ≥ 45 years old were more likely to undergo BCS (Table 2). Compared with women in 1998-1999, women diagnosed since 1999 were more likely to undergo BCS; this peaked in 2006-2007 (OR, 1.23; 95% CI, 1.16-1.31) and subsequently declined. Ancestry/ethnicity was associated with BCS treatment because women of African and Hispanic ancestry were more likely to undergo BCS. Surgery patterns changed over time according to ancestry/ethnicity, with BCS rates for women of African ancestry being lowest in 1998, whereas women of European ancestry had the lowest rates in 2011 (data not shown). Women outside the Northeast had lower odds of undergoing BCS.

BCS With Adjuvant Radiation Therapy

Age was associated with the likelihood of undergoing adjuvant radiation therapy after BCS (Table 3). There was an increase in the proportion of women undergoing

TABLE 3. Demographics of Radiation Treatment After BCS for Ductal Carcinoma In Situ in the National Cancer Data Base, 1998-2011

Variable	BCS Only (n = 95,076), % by Row	BCS With Adjuvant Radiation (n = 189,847), % by Row	OR (95% CI)[a]
Age group			
<45 y	31.0	69.0	1
45-54 y	29.1	70.9	1.07 (1.04-1.11)
55-64 y	28.3	71.8	1.10 (1.07-1.14)
65-74 y	32.7	67.3	0.95 (0.92-0.98)
≥75 y	52.2	47.8	0.41 (0.39-0.43)
Year of diagnosis			
1998-1999	41.4	58.6	1
2000-2001	39.1	60.9	1.07 (1.04-1.11)
2002-2003	36.2	63.8	1.12 (1.08-1.16)
2004-2005	32.4	67.6	1.19 (1.13-1.25)
2006-2007	29.2	70.8	1.38 (1.31-1.46)
2008-2009	29.1	70.9	1.40 (1.32-1.47)
2010-2011	29.9	70.1	1.32 (1.25-1.39)
Ancestry/ethnicity			
Non-Hispanic European	32.9	67.1	1
Non-Hispanic African	34.2	65.8	0.92 (0.90-0.95)
Hispanic	36.8	63.2	0.86 (0.83-0.90)
Other	35.6	64.4	0.89 (0.86-0.93)
Geographic region			
Northeast	36.2	63.8	1
Midwest	25.8	74.2	1.62 (1.58-1.65)
South	35.0	65.0	0.99 (0.97-1.01)
West	36.9	63.1	0.83 (0.81-0.85)

Abbreviations: BCS, breast-conserving surgery; CI, confidence interval; OR, odds ratio.
For the test of interaction between the year of diagnosis and ancestry/ethnicity, χ^2 was 21.03, the degrees of freedom were 18, and *P* was .28.
[a] Adjusted for the comorbidity index, health insurance, facility type, facility ductal carcinoma in situ patient volume, and tumor size and grade.

adjuvant radiation therapy after BCS from 58.5% in 1998-1999 to 70% during 2006-2011. Women of European ancestry were more likely to undergo adjuvant radiation therapy after BCS than other ancestral/ethnic groups. Women in the Midwest were more likely to receive adjuvant radiation therapy after BCS.

Breast Reconstruction After Mastectomy

A younger age at diagnosis was associated with undergoing breast reconstruction (Table 4). Women diagnosed in 2010-2011 were more likely to undergo reconstruction after mastectomy than women in 1998-1999 (OR, 3.57; 95% CI, 3.27-3.91). Breast reconstruction rates have been increasing among the 3 racial/ancestral groups, with women of European ancestry having the highest rates (Fig. 1A). Women in the Northeast were more likely to undergo breast reconstruction after mastectomy.

Contralateral Risk-Reducing Mastectomy

Rates of contralateral risk-reducing mastectomy decreased with an increasing age at diagnosis (Table 4). Women diagnosed in 2010 were more likely to undergo contralateral mastectomy than women diagnosed in 1998-1999 (OR, 4.56; 95% CI, 4.09-5.08). The annual proportion of women undergoing contralateral mastectomy increased in all 3 racial/ancestral groups (Fig. 1B). Women outside the Northeast were more likely to undergo contralateral mastectomy.

DISCUSSION

In analyzing the patterns of care for DCIS among women in a large nationwide clinical database, we observed an increase in BCS among women diagnosed with DCIS between 1998 and 2005. This was followed by a decline in BCS through 2011 with a corresponding rise in mastectomy utilization. This is consistent with previous observations of increasing mastectomy rates among women with early-stage breast cancer.[19,20] Unlike previous studies, which included small invasive node-negative cancers and in situ cancer, we observed these findings specifically among DCIS patients.

Using the NCDB, we observed an increase in adjuvant radiation therapy utilization after BCS until 2007. BCS and adjuvant radiation treatment are beneficial in preventing localized ipsilateral breast cancer recurrence in comparison with BCS alone, with a survival benefit similar to that of mastectomy.[11,21] Although most women

TABLE 4. Demographics of Reconstruction and Contralateral Risk-Reducing Mastectomy for Women Diagnosed With Ductal Carcinoma In Situ in the National Cancer Data Base, 1998-2011

Variable	Mastectomy Alone (n = 87,130), % by Row	Mastectomy With Reconstruction (n = 44,179), % by Row	OR (95% CI)[a]	Unilateral Mastectomy (n = 104,970), % by Row	Contralateral Mastectomy (n = 26,339), % by Row	OR (95% CI)[a]
Age group						
<45 y	45.5	54.5	1	67.1	32.9	1
45-54 y	52.0	48.0	0.75 (0.72-0.79)	73.6	26.4	0.67 (0.65-0.70)
55-64 y	66.0	34.0	0.42 (0.41-0.44)	80.3	19.7	0.45 (0.43-0.47)
65-74 y	83.9	16.1	0.24 (0.23-0.25)	88.8	11.2	0.29 (0.27-0.31)
≥75 y	95.9	4.1	0.06 (0.05-0.06)	94.8	5.2	0.13 (0.12-0.14)
Year of diagnosis						
1998-1999	78.7	21.3	1	91.4	8.6	1
2000-2001	74.5	25.5	1.31 (1.24-1.38)	88.4	11.6	1.43 (1.33-1.54)
2002-2003	72.9	27.1	1.40 (1.31-1.49)	85.0	15.0	1.85 (1.70-2.01)
2004-2005	69.9	30.1	1.57 (1.43-1.72)	82.0	18.0	2.12 (1.93-2.41)
2006-2007	64.5	35.5	2.04 (1.86-2.23)	77.3	22.7	2.95 (2.64-3.29)
2008-2009	58.5	41.5	2.76 (2.52-3.02)	72.8	27.2	3.79 (3.40-4.23)
2010-2011	53.6	46.4	3.57 (3.27-3.91)	69.7	30.3	4.56 (4.09-5.08)
Ancestry/ethnicity						
Non-Hispanic European	65.5	34.5	1	78.5	21.5	1
Non-Hispanic African	72.0	28.0	0.69 (0.66-0.72)	88.5	11.5	0.43 (0.41-0.45)
Hispanic	66.3	33.7	0.83 (0.78-0.89)	83.2	16.8	0.57 (0.53-0.62)
Other	68.0	32.0	0.66 (0.63-0.70)	82.9	17.1	0.56 (0.52-0.60)
Geographic region						
Northeast	60.6	39.5	1	81.2	18.8	1
Midwest	66.0	34.0	0.88 (0.85-0.92)	80.6	19.5	1.14 (1.10-1.20)
South	68.5	31.5	0.81 (0.78-0.84)	80.0	20.0	1.29 (1.24-1.34)
West	69.0	31.0	0.72 (0.68-0.75)	77.4	22.6	1.49 (1.42-1.56)

Abbreviations: BCS, breast-conserving surgery; CI, confidence interval; OR, odds ratio.
For the test of interaction between the year of diagnosis and ancestry/ethnicity for reconstruction, χ^2 was 25.90, the degrees of freedom were 18, and *P* was .10. For the test of interaction between the year of diagnosis and ancestry/ethnicity for contralateral risk-reducing mastectomy, χ^2 was 27.63, the degrees of freedom were 18, and *P* was .07.
[a] Adjusted for the comorbidity index, health insurance, facility type, facility ductal carcinoma in situ patient volume, and tumor size and grade.

were treated with BCS and adjuvant radiation therapy (46%), the proportion of women undergoing adjuvant radiation therapy after BCS plateaued at 70% after 2007. The increasing trend in the proportion of women undergoing adjuvant radiation therapy after a DCIS diagnosis has been previously shown.[8,22] However, our findings suggest adjuvant radiation therapy utilization may be at a saturation level. Not all women diagnosed with DCIS and undergoing BCS are ideal candidates for adjuvant radiation therapy, and women may have concerns regarding adverse effects of radiation. Social factors such as cultural beliefs, marital status, and social support may be related to the choice of undergoing radiation therapy after BCS.[23,24] In terms of population density/metro areas, previous research has demonstrated differences in the receipt of radiotherapy among breast cancer patients.[25] Specifically, a greater proportion of women dwelling in urban areas receive adjuvant radiation treatment in comparison with women with rural residence locations. In addition, women living at an increased distance from a hospital with a radiotherapy facility are less likely to undergo BCS.[26]

Since 2005, the proportion of women undergoing mastectomy after DCIS has increased even though BCS with adjuvant radiation therapy is generally an appropriate and less extensive treatment option. Apart from concerns about the effects of radiation therapy, some women may be dissatisfied with their cosmetic outcome after BCS.[27] Breast reconstruction after mastectomy may be favored for cosmetic and psychological reasons.[28,29] Legislative mandates such as the Women's Health and Cancer Rights Act, requiring coverage for breast reconstruction after mastectomy by most insurance plans, may have influenced the increase. A recent study observed 2-to 4-fold increases in reconstruction after the enactment of the legislation.[30]

Throughout the study period, women of European ancestry consistently had higher proportions undergoing breast reconstruction after mastectomy. However, women of African ancestry and Hispanic women showed an increasing trend in postmastectomy reconstruction almost parallel to that observed among women of European ancestry. A lack of insurance coverage, a lack of knowledge

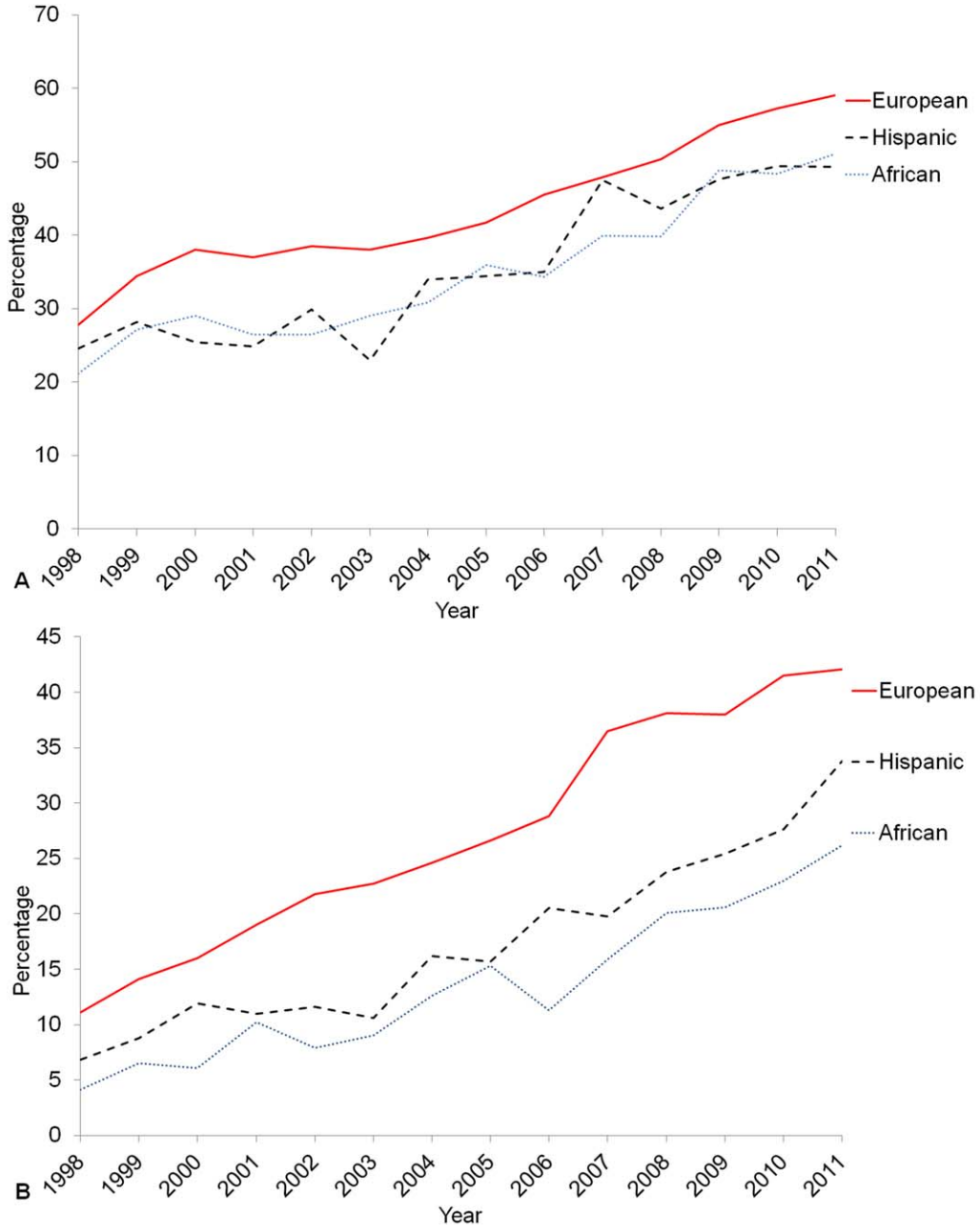

Figure 1. Age-adjusted annual proportions of patients undergoing (A) reconstruction and (B) risk-reducing contralateral mastectomy among women with mastectomy for ductal carcinoma in situ according to European, African, and Hispanic ancestry (National Cancer Data Base, 1998-2011).

about postmastectomy reconstruction, cultural issues, and socioeconomic status have been previously associated with observed differences in postmastectomy reconstruction by ancestry/ethnicity.[31,32]

We observed an increasing trend in the utilization of contralateral risk-reducing mastectomy among women undergoing mastectomy and a more rapid rise among women of European ancestry compared to other racial/ancestral groups. This trend has been observed previously among woman who are less than 45 years old and have been diagnosed with early-stage breast cancer.[33] Previous research has also shown similar prevalences of *BRCA1/BRCA2* mutations among breast cancer patients of European, African, and Hispanic ancestry.[34] Mammography screening rates appear to be higher among women of European ancestry.[35,36] Ancestral/ethnic differences in

screening may lead to differences in diagnosis and treatment. Furthermore, previous research has shown that women of European ancestry are less likely to delegate treatment decisions to their physicians.[37] This may be related to higher educational attainment.[38] Women with higher levels of educational attainment have increased participation in surgical decision making and are more likely to undergo mastectomy.[39,40]

Breast cancer diagnosed in younger women is associated with a higher risk of recurrence after BCS.[41] Undergoing lifelong surveillance may be disruptive and anxiety-provoking for some. Hence, younger women may prefer to undergo mastectomy, including the removal of the uninvolved breast. The decision to undergo mastectomy may be influenced by multifocal or widespread disease, positive margins, age, physician's preference, access to radiation facilities, fear of recurrence, and insurance coverage.[19,20,42] For many women, bilateral mastectomy may be considered aggressive treatment because of the generally low absolute risk of a future invasive carcinoma. There is no overall survival benefit for contralateral risk-reducing mastectomy in early-stage breast cancer among estrogen receptor–negative patients.[43] Survival benefits seen in some studies may be due to a selection bias.[44] Among *BRCA1*/*BRCA2* mutation carriers, contralateral mastectomy may confer a survival advantage.[45] Despite overall survival comparable to that achieved with BCS with adjuvant radiation therapy, mastectomy in some instances may be a preferred treatment option among women diagnosed with DCIS without any deleterious BRCA mutations (eg, multifocal disease).[6,11] The role of contralateral mastectomy for DCIS treatment in general is debatable.

Geographical variations in the utilization of surgical treatments, including postmastectomy reconstruction among women diagnosed with DCIS, have been documented previously.[8] We observed persistent geographic variations in the utilization of DCIS treatment options. For instance, women in the Northeast had the greatest odds of undergoing BCS and reconstruction after mastectomy and the smallest odds of undergoing contralateral mastectomy. This may suggest a preference toward aesthetic preservation in the Northeast. Regional variations may reflect practice differences among institutions and available surgical expertise. In our study, the West and South, in comparison with the Northeast, had the highest ORs for contralateral mastectomy and the lowest ORs for BCS alone and BCS with adjuvant radiation therapy. The variations observed in the utilization of contralateral mastectomy may be related to physician preferences, including institutional practice patterns, and access to radiation treatment facilities.[26,46] The presence of more surgeons with reconstruction expertise in treatment facilities is associated with increased utilization of these procedures after mastectomy.[10]

The NCDB is a rich resource for examining patterns of DCIS treatment, but it does have limitations. Cancer cases are only from Commission on Cancer–accredited hospitals. Hence, the NCDB may represent select cases. The inability to differentiate between immediate and delayed reconstruction is another limitation. The absence of data on the hormone receptor status and human epidermal growth factor receptor 2 for most patients and the lack of information on some genetic markers such as the *BRCA* gene status precluded the assessment of treatment variation according to DCIS molecular subtypes and genetic risk. Finally, we lacked information on patients' preferences and physician's characteristics, including variations in the geographic distribution of reconstructive surgeons and radiation oncologists. However, our study findings corroborate findings from population-based cancer registry data such as Surveillance, Epidemiology, and End Results data.[19,20] The NCDB has the added advantage of being the largest national cancer registry, with data from more than 70% of new cancer cases and from health facilities ranging from academic facilities to community-based cancer facilities. With this resource, we have been able to provide updated information regarding trends in local therapies for DCIS treatment with the discovery of some new findings.

In conclusion, in assessing patterns of care for women diagnosed with DCIS, we found substantial variation in all 4 major local-treatment decisions. Significant differences between treatment types were observed according to ancestry/ethnicity and geographical region. There has been increasing utilization of adjuvant radiation treatment after BCS and breast reconstruction after mastectomy since 1998. These increases coincided with the introduction of policies and clinical guidelines that favored their utilization. The study period mostly encompassed the years before the passage of the Patient Protection and Affordable Care Act of 2010. It will be interesting to examine trends in DCIS treatment after the implementation of this legislation. Finally, the impact of treatment variation on cancer recurrence and progression to invasive cancer warrants further investigation.

FUNDING SUPPORT

This study was supported by the National Institutes of Health/National Cancer Institute (grants U54 CA163303, R01 CA067264, and P30 CA014520).

CONFLICT OF INTEREST DISCLOSURES

Sally Herschorn and her spouse owned a small amount of stock in Hologic, Inc (a company that makes mammography equipment), when the study was performed; they no longer own the stock.

AUTHOR CONTRIBUTIONS

Oyewale O. Shiyanbola: Conception and design, data analysis and interpretation, manuscript writing, and final approval. **Brian L. Sprague:** Conception and design, data analysis and interpretation, manuscript writing, and final approval. **John M. Hampton:** Data analysis and interpretation and final approval. **Kim Dittus:** Data analysis and interpretation, manuscript writing, and final approval. **Ted A. James:** Data analysis and interpretation, manuscript writing, and final approval. **Sally Herschorn:** Data analysis and interpretation, manuscript writing, and final approval. **Ronald E. Gangnon:** Data analysis and interpretation, manuscript writing, and final approval. **Donald L. Weaver:** Conception and design, data analysis and interpretation, manuscript writing, and final approval. **Amy Trentham-Dietz:** Conception and design, data analysis and interpretation, manuscript writing, and final approval

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