Influence of Facility Characteristics on Access to Breast Reconstruction: A 12-Year National Cancer Database Analysis

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Abstract. *Background/Aim:* This study aimed to analyze facility characteristics contributing to disparities in breast reconstruction access in the United States. *Patients and Methods:* Data from January 1, 2004, to December 31, 2015 were extracted from the National Cancer Database on patient, facility and treatment, and tumor characteristics. A total of 858,594 patients met the inclusion criteria of the study, including 553,517 (64.5%) patients who underwent mastectomy only (without breast reconstruction) and 305,077 (35.5%) patients who received breast reconstruction (implants or autologous tissue). *Results:* Multivariate analysis showed that the odds of reconstruction were higher in Integrated Network Cancer Programs and Academic/Research Programs compared to Community Cancer Programs. Patients treated in the South, Midwest, and West regions had lower odds of reconstruction. Interestingly, patients treated in more than one Commission on Cancer facility had a higher likelihood of reconstruction. *Conclusion:* Facility characteristics and location impact on access to breast reconstruction.

Breast cancer is the most common malignancy diagnosed in women worldwide and in the United States (excluding non-melanoma skin cancer) as reported by the World Health Organization (1). Despite the well-established benefits of undergoing post-mastectomy breast reconstruction, we often fail to consistently integrate reconstructive options for all patients in all regions throughout the United States as part

of the treatment of breast cancer (2). Legislative movements and efforts within the United States, such as the Women's Health and Cancer Rights Act of 1998 and the Breast Cancer Patient Education Act of 2015 have aimed at improving access in underserved and under-recognized populations to breast reconstruction (3). Although these initiatives have shown great dedication and promise, previous studies on access equitability have demonstrated a suboptimal delivery of breast reconstruction services, suggesting the continued existence of barriers to access (4).

Prior analyses of the disparities in access to breast reconstruction in the United States have offered limited insight into the specific barriers driving the discrepancies. While the decision to pursue post-ablative reconstruction of breast tissue certainly lies with the individual patient and their desires, the evident milieu of inequitable rates of breast reconstruction between individuals of different backgrounds and access suggest that these important services are not being actively presented to all women in an even distribution. The goal of this study was to analyze facility characteristics contributing to disparities in access to breast reconstruction in the United States.

Patients and Methods

The National Cancer Database (NCDB) is a program of the Commission on Cancer (CoC) of the American College of Surgeons and the American Cancer Society. This program maintains a database that collects information of approximately 70% of the newly diagnosed cancer patients in the United States (5). Data are submitted by Certified Tumor Registrars who are trained to submit patient information into the NCDB. Submitted data are revised and, if found incomplete or inaccurate, sent back to the submitting institution for correction (5). Our study was considered exempt by the institutional review board.

Eligible cases were identified using the NCDB Participant User File of breast cancer patients. Data were extracted for all patients

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Table I. Patient demographic and clinical data by presence or absence of breast reconstruction.

Variable	Mastectomy only		Reconstruction		p-Value
	No.	%	No.	%	
Total	553,517	64.5%	305,077	35.5%	
Age, mean (SD)	62.75 (13.752)		52.07 (10.835)		<0.001
Age					<0.001
<49	105,820	19.1%	132,518	43.4%	
50-59	119,911	21.7%	95,212	31.2%	
60-69	140,387	25.4%	59,394	19.5%	
70-79	118,438	21.4%	15,933	5.2%	
≥80	68,961	12.5%	2,020	0.7%	
Race					<0.001
White	454,668	82.1%	260,525	85.4%	
Black	66,765	12.1%	28,755	9.4%	
Native American	1,790	0.3%	661	0.2%	
Asian	21,355	3.9%	9,661	3.2%	
Other or unknown	8,939	1.6%	5,475	1.8%	
Insurance status					<0.001
Not insured	14,283	2.6%	4,125	1.4%	
Private insurance	240,369	43.4%	234,699	76.9%	
Medicaid	39,747	7.2%	16,532	5.4%	
Medicare	240,782	43.5%	43,135	14.1%	
Other government	5,159	0.9%	3,669	1.2%	
Unknown	13,177	2.4%	2,917	1.0%	
Income					<0.001
<\$38,000	100,658	18.2%	32,417	10.6%	
\$38,000-\$47,999	131,223	23.7%	52,791	17.3%	
\$48,000-\$62,999	148,388	26.8%	77,596	25.4%	
≥\$63,000	168,433	30.4%	140,437	46.0%	
Unknown	4,815	0.9%	1,836	0.6%	
Education					<0.001
≥21%	96,905	17.5%	33,867	11.1%	
13%-20.9%	143,050	25.8%	62,732	20.6%	
7%-12.9%	177,200	32.0%	99,755	32.7%	
<7%	131,817	23.8%	106,967	35.1%	
Unknown	4,545	0.8%	1,756	0.6%	
Urbanicity					<0.001
Metropolitan	448,877	81.1%	264,724	86.8%	
Non-metropolitan, adjacent to metro	59,986	10.8%	22,010	7.2%	
Non-metropolitan, not adjacent to metro	29,285	5.3%	9,928	3.3%	
Unknown	15,369	2.8%	8,415	2.8%	
Charlson Deyo Comorbidity score					<0.001
0	445,974	80.6%	269,997	88.5%	
1	85,308	15.4%	30,553	10.0%	
≥2	22,235	4.0%	4,527	1.5%	
Facility type					<0.001
Community Cancer Program	62,122	11.2%	15,731	5.2%	
Comprehensive Community Cancer Program	263,639	47.6%	122,457	40.1%	
Academic/Research Program	147,234	26.6%	96,236	31.5%	
Integrated Network Cancer Program	55,427	10.0%	35,710	11.7%	
Other or unknown	25,095	4.5%	34,943	11.5%	
Facility location					<0.001
Northeast	90,550	16.4%	60,317	19.8%	
South	213,569	38.6%	99,603	32.6%	
Midwest	134,447	24.3%	68,072	22.3%	
West	89,856	16.2%	42,142	13.8%	
Unknown	25,095	4.5%	34,943	11.5%	
Number of CoC facilities					<0.001
1	451,268	81.7%	238,946	78.3%	
>1	101,149	18.3%	66,131	21.7%	

χ^2 test was used for the analysis.

Table II. Odds of breast reconstruction among post-mastectomy breast cancer patients.

Variables	OR	95%CI		p-Value
		Lower	Upper	
Facility type				
Community Cancer Program	1		Referential	-
Comprehensive Community Cancer Program	1.601	1.568	1.635	<0.001
Academic/Research Program	1.925	1.884	1.967	<0.001
Integrated Network Cancer Program	2.196	2.142	2.252	<0.001
Other or unknown	0.897	0.87	0.925	<0.001
No. of facilities				
Only one CoC facility	1		Referential	-
More than one CoC facility	1.079	1.065	1.093	<0.001
Facility region				
Northeast	1		Referential	-
South	0.866	0.852	0.879	<0.001
Midwest	0.884	0.87	0.898	<0.001
West	0.757	0.743	0.771	<0.001

Multivariate analysis for breast reconstruction (vs. mastectomy alone, ref). Adjusted by race, income, education, insurance status, urbanicity, year of diagnosis, grade, AJCC stage, behavior, primary site, node status, grade, size, and metastasis at diagnosis.

diagnosed with breast cancer who underwent mastectomy from January 1, 2004, to December 31, 2015. The cohort was then split into two groups based on whether or not they received breast reconstruction. To reduce bias in our final cohort, we excluded men and patients with American Joint Committee on Cancer (AJCC) stage IV or for whom stage was unknown, those who did not undergo mastectomy, and those whose surgical treatment was unknown.

Data were extracted on patient, facility and treatment, and tumor characteristics. Patient characteristics included age, race, insurance (*i.e.*, not insured, private, Medicaid, Medicare, other government), income (*i.e.*, median household income in the area of residency), level of education (*i.e.*, percentage of adults who did not graduate high school in the area of residency), urbanicity of region of residence (*i.e.*, metropolitan, non-metropolitan adjacent to metro, non-metropolitan not adjacent to metro), and Charlson-Deyo comorbidity score. Facility and treatment characteristics included facility type, location, multisource (*i.e.* number of facilities the patient was treated in), days to start of treatment, days to most effective surgery, and days to surgical discharge. Tumor characteristics included primary site, behavior, size, grade, node status, metastasis at diagnosis, and AJCC stage.

Patient, facility and treatment, and tumor characteristics were described and analyzed using χ^2 or Mann-Whitney tests as appropriate. Multivariate analysis was performed using a logistic regression model to assess independent associations, adjusting for confounders. The outcome variable was set as receipt of breast reconstruction and the predicted variables were facility type, facility region, and number of facilities that treated the patient. The model was adjusted for confounders related to patient characteristics, tumor characteristics, and year of diagnosis. The significance level was set at $p < 0.05$. Statistical analysis was done using SPSS, version 25.0, statistical software (SPSS Inc.).

Results

A total of 858,594 patients met the inclusion criteria of the study. The analyzed cohort included 553,517 (64.5%) patients

who underwent mastectomy only, without documented reconstructive intervention, and 305,077 (35.5%) patients who received breast reconstruction following ablative surgery. Breast reconstruction was significantly more prevalent among patients who were younger than 59 years of age, white, privately insured, without comorbidities, living in metropolitan counties and areas with higher annual income ($\geq \$63,000$), and higher education ($< 7.0\%$ of adults did not graduate from high school in area of residency). Moreover, breast reconstruction was more prevalent in Academic/Research Programs or Integrated Network Cancer Programs and in the Northeast region ($p < 0.001$) (Table I).

Breast reconstruction was proportionally more prevalent in less aggressive tumors (*i.e.*, *in situ*, < 2 cm, node status negative, AJCC stages 0-1, and without metastasis at diagnosis) ($p < 0.001$). Patients who underwent reconstruction had a significantly greater mean (SD) time to start of treatment [35.65 (32.58) days vs. 30.45 (32.84) days; $p < 0.001$], to receiving the most effective surgery [73.2 (69.64) days vs. 70.49 (60.49) days; $p < 0.001$], and to being discharged after surgery [2.26 (6.678) days vs. 1.66 (5.632) days; $p < 0.001$].

The odds of reconstruction were higher in Integrated Network Cancer Program [odds ratio (OR)=2.196; 95%CI=2.142-2.252; $p < 0.001$] and Academic/Research Programs (OR=1.925; 95%CI=1.884-1.967; $p < 0.001$) compared to Community Cancer Programs. Moreover, patients treated in the South, Midwest, and West regions had lower odds of reconstruction compared to the Northeast region. Interestingly, we noted that patients treated in more than one CoC facility had a higher likelihood of reconstruction (OR=1.079; 95%CI=1.065-1.093; $p < 0.001$) compared to those treated in only one CoC facility (Table II).

Discussion

To our knowledge, this is the largest study to date to analyze the impact of facility characteristics and of being treated in more than one CoC facility on access to breast reconstruction among breast cancer patients. Interestingly, we noticed higher odds of reconstruction in Integrated Network Cancer Programs, Academic/Research Programs, and facilities located in the Northeast region. Moreover, patients treated in more than one CoC facility were more likely to receive reconstruction compared to those treated in only one CoC facility.

Impact of facility location on breast cancer care has been previously studied in the literature. Seriego *et al.*, (6) in a study of NCDB data between 1999 and 2003, demonstrated a significant correlation between geographic region and initial breast cancer treatment. Butler *et al.*, (7) analyzing rates of immediate breast reconstruction in state inpatient and ambulatory surgery databases, reported that plastic surgeon density is directly related to breast reconstruction rate. Shippee *et al.* (8) reviewed the Nationwide Inpatient Sample data between 2002 and 2006, and found that hospitals in urban locations were significantly associated with increased likelihood of access to breast reconstruction. In our analysis, facility location also impacted access to breast reconstruction, since we found that patients treated in the South, Midwest, and West regions had lower odds of reconstruction compared to those in the Northeast region.

Academic facilities have been related to increased rates of breast reconstruction in previous publications. Alborno *et al.* (9) reviewed NCDB data for patients who had undergone mastectomy from 1998 to 2011, who either received or did not receive breast reconstruction to determine whether geographic disparities limit the rate and method of postmastectomy reconstruction. They noticed that rates of breast reconstruction were significantly greater at academic programs, and patients who had received breast reconstruction had to travel farther than those who had undergone mastectomy alone (9). Sisco *et al.* (10) examined NCDB data on patients who underwent mastectomy for stage 0 to III breast cancer between 1998 and 2007 (n=452,903), evaluating trends in the receipt of immediate and early delayed breast reconstruction. They demonstrated that treatment in an academic/research hospital was a predictor of breast reconstruction over the study period (10). Furthermore, Kruper *et al.* (11) analyzing the California Office of Statewide Health Planning and Development inpatient database from 2003 to 2007, noticed that most reconstructive procedures were performed at teaching hospitals and designated cancer centers. Our results agreed with these publications as we also found that Academic/Research Programs have increased odds of breast reconstruction.

A strength of this study is the large sample taken from the NCDB, which records approximately 70% of the newly

diagnosed cancer patients in the United States. However, studies on national patient databases have limitations that merit consideration, including missing data, potential for coding errors, and retrospective nature. While we observed a declining trend in the number of postmastectomy patients not undergoing breast reconstruction, a limitation to using NCDB data is that it does not allow assessment of the reasons why breast reconstruction is not performed. We encourage further studies to address the factors related to these disparities and determine interventions at both the clinical practice and legislative levels to positively affect these disadvantaged populations.

In summary, patients are more likely to undergo breast reconstruction when treated at Integrated Network Cancer Programs, Academic/Research Programs, facilities located in the Northeast region, and at more than one CoC facility. These results should be taken into consideration for initiatives to overcome barriers on access to breast reconstruction.

Conflicts of Interest

The Authors have no conflicts of interest to declare regarding this study.

Authors' Contributions

DB, DJR, and AJF had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: DB, AJF, ACS, EG. Acquisition, analysis, or interpretation of data: DB, DJR, AJF. Drafting of the manuscript: DB, DJR, MTH, AS. Critical revision of the manuscript for important intellectual content: SM, MTH, ACS, EG, and AJF. Study supervision: AJF.

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References

- 1 Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, Parkin DM, Forman D and Bray F: Cancer incidence and mortality worldwide: Sources, methods and major patterns in globocan 2012. *Int J Cancer* 136(5): E359-386, 2015. PMID: 25220842. DOI: 10.1002/ijc.29210
- 2 Maly RC, Liu Y, Kwong E, Thind A and Diamant AL: Breast reconstructive surgery in medically underserved women with breast cancer: The role of patient-physician communication. *Cancer* 115(20): 4819-4827, 2009. PMID: 19626696.
- 3 Zhong T, Fernandes KA, Saskin R, Sutradhar R, Platt J, Beber BA, Novak CB, McCready DR, Hofer SO, Irish JC and Baxter NN: Barriers to immediate breast reconstruction in the canadian universal health care system. *J Clin Oncol* 32(20): 2133-2141, 2014. PMID: 24888814. DOI: 10.1200/jco.2013.53.0774

- 4 Retrouvey H, Solaja O, Gagliardi AR, Webster F and Zhong T: Barriers of access to breast reconstruction: A systematic review. *Plast Reconstr Surg* 143(3): 465e-476e, 2019. PMID: 30817637. DOI: 10.1097/prs.00000000000005313
- 5 Bilimoria KY, Stewart AK, Winchester DP and Ko CY: The national cancer data base: A powerful initiative to improve cancer care in the united states. *Ann Surg Oncol* 15(3): 683-690, 2008. PMID: 18183467. DOI: 10.1245/s10434-007-9747-3
- 6 Sariego J: Regional variation in breast cancer treatment throughout the united states. *Am J Surg* 196(4): 572-574, 2008. PMID: 18809065. DOI: 10.1016/j.amjsurg.2008.06.017
- 7 Butler PD, Familusi O, Serletti JM and Fox JP: Influence of race, insurance status, and geographic access to plastic surgeons on immediate breast reconstruction rates. *Am J Surg* 215(6): 987-994, 2018. PMID: 29103529. DOI: 10.1016/j.amjsurg.2017.09.037
- 8 Shippee TP, Kozhimannil KB, Rowan K and Virnig BA: Health insurance coverage and racial disparities in breast reconstruction after mastectomy. *Womens Health Issues* 24(3): e261-269, 2014. PMID: 24794541. DOI: 10.1016/j.whi.2014.03.001
- 9 Albornoz CR, Bach PB, Pusic AL, McCarthy CM, Mehrara BJ, Disa JJ, Cordeiro PG and Matros E: The influence of sociodemographic factors and hospital characteristics on the method of breast reconstruction, including microsurgery: A u.s. Population-based study. *Plast Reconstr Surg* 129(5): 1071-1079, 2012. PMID: 22544091. DOI: 10.1097/PRS.0b013e31824a29c5
- 10 Sisco M, Du H, Warner JP, Howard MA, Winchester DP and Yao K: Have we expanded the equitable delivery of postmastectomy breast reconstruction in the new millennium? Evidence from the national cancer data base. *J Am Coll Surg* 215(5): 658-666; discussion 666, 2012. PMID: 22921327. DOI: 10.1016/j.jamcollsurg.2012.07.008
- 11 Kruper L, Holt A, Xu XX, Duan L, Henderson K, Bernstein L and Ellenhorn J: Disparities in reconstruction rates after mastectomy: Patterns of care and factors associated with the use of breast reconstruction in southern california. *Ann Surg Oncol* 18(8): 2158-2165, 2011. PMID: 21308486. DOI: 10.1245/s10434-011-1580-z

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