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Louisa C. Boyd

Jason A. Greenfield

Sravya S. Ainapurapu

Rachel Skladman

Gary Skolnick

See next page for additional authors

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Authors

Louisa C. Boyd, Jason A. Greenfield, Sravya S. Ainapurapu, Rachel Skladman, Gary Skolnick, Durai Sundaramoorthi, and Justin M. Sacks

The Insurance Landscape for Implant- and Autologous-based Breast Reconstruction in the United States

Louisa C. Boyd, MD*

Jason A. Greenfield, BA†

Sravya S. Ainapurapu, BA‡

Rachel Skladman, MD§

Gary Skolnick, MBA, BA§

Durai Sundaramoorthi, PhD¶

Justin M. Sacks, MD, MBA, FACS§

Background: Insurance coverage of postmastectomy breast reconstruction is mandated in America, regardless of reconstructive modality. Despite enhanced patient-reported outcomes, autologous reconstruction is utilized less than nonautologous reconstruction nationally. Lower reimbursement from Medicare and Medicaid may disincentivize autologous-based reconstruction. This study examines the impact of insurance and sociodemographic factors on breast reconstruction.

Methods: A retrospective analysis of the Healthcare Cost and Utilization Project National Inpatient Sample Database from 2014 to 2017 was performed. International Classification of Diseases Clinical Modification and Procedure Coding System codes were used to identify patients for inclusion. De-identified sociodemographic and insurance data were analyzed using χ^2 , least absolute shrinkage and selection operator regression analysis, and classification trees.

Results: In total, 31,468 patients were identified for analysis and stratified by reconstructive modality, sociodemographics, insurance, and hospital characteristics. Most patients underwent nonautologous reconstruction (63.2%). Deep inferior epigastric perforator flaps were the most common autologous modality (46.7%). Least absolute shrinkage and selection operator regression identified Black race, urban-teaching hospitals, nonsmoking status, and obesity to be associated with autologous reconstruction. Publicly-insured patients were less likely to undergo autologous reconstruction than privately-insured patients. Within autologous reconstruction, publicly-insured patients were 1.97 ($P < 0.001$) times as likely to obtain pedicled flaps than free flaps. Black patients were 33% ($P < 0.001$) less likely to obtain free flaps than White patients.

Conclusions: Breast reconstruction is influenced by insurance, hospital demographics, and sociodemographic factors. Action to mitigate this health disparity should be undertaken so that surgical decision-making is solely dependent upon medical and anatomic factors. (*Plast Reconstr Surg Glob Open* 2023; 11:e4818; doi: 10.1097/GOX.0000000000004818; Published online 17 February 2023.)

From the *Division of Plastic and Reconstructive Surgery, Saint Louis University School of Medicine, Saint Louis, Mo.; †Miller School of Medicine, University of Miami, Miami, Fla.; ‡James McKelvey School of Engineering, Washington University in Saint Louis, Saint Louis, Mo.; §Division of Plastic and Reconstructive Surgery, Washington University School of Medicine, Saint Louis, Mo.; and ¶Olin School of Business, Washington University in Saint Louis, Saint Louis, Mo.

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INTRODUCTION

Due to the life-enhancing, rather than life-extending, nature of postmastectomy reconstruction, health insurance coverage has historically been limited across both private and public plans.¹ The Women's Health and Cancer Rights Act was implemented in 1998 in order to mitigate this disparity in access to breast reconstruction,

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requiring that all insurance plans that cover mastectomies also provide coverage for breast reconstruction, regardless of the modality. Following the Women's Health and Cancer Rights Act, 19 states passed additional legislation to expand public insurance coverage for breast reconstruction.² Subsequently, reconstruction rates increased by 17% over the next decade.³ The recent passage of the Affordable Healthcare Act in 2010 aimed to expand healthcare access for all, also hypothetically translating to increased access to postmastectomy reconstruction. Although it was presumed that widened access to breast reconstruction would serve to diminish the historic inequity of breast reconstruction, research examining the effects of these policies found no significant change in the previously observed geographic, racial, and ethnic disparities associated with these procedures.^{4,5}

Although autologous reconstruction has demonstrated enhanced patient-reported outcomes, it is less utilized relative to nonautologous reconstruction and a national trend favoring implant-based reconstruction has developed in recent years.^{6,7} It has been proposed that relatively low reimbursement rates from Medicare and Medicaid do not provide sufficient compensation for the increased procedural time and technical skill required for autologous reconstruction, thus disincentivizing utilization of autologous-based reconstruction and possibly accounting for the increasing rates of implant-based reconstruction nationally.^{8,9}

Previous research has identified a significant disparity in reconstructive modality, based on insurance status, race, and other sociodemographic characteristics. Nonminority, privately-insured women from advantageous socioeconomic backgrounds have been shown to receive autologous-based reconstruction at much higher rates than other breast cancer reconstruction patients.¹⁰⁻¹² Of those patients who do undergo autologous reconstruction, the privately insured have been shown to receive free flap, rather than pedicled, reconstruction at significantly higher rates than those insured by Medicare or Medicaid.^{8,10}

This study aimed to determine the influence of insurance, sociodemographic factors, and hospital characteristics on breast reconstruction modality, with the ultimate goal of identifying any insurance disparities that may limit equitable access to breast reconstruction. We hypothesized that despite favorable legislation ensuring coverage for postmastectomy breast reconstruction, institutions across the nation may preferentially perform free-flap-based reconstruction on patients with private insurance coverage.

METHODS

A retrospective analysis of all breast reconstruction patients from 2014 to 2017 was conducted using the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) Database. No institutional review board approval was required as the HCUP NIS Database contains de-identified and publically available data.

Takeaways

Question: Does insurance payer influence whether a patient undergoes autologous versus non-autologous breast reconstruction following mastectomy?

Findings: This national database review supports that Black race, urban-teaching hospitals, non-smoking status, and obesity are associated with autologous reconstruction. Publicly-insured patients are significantly less likely to undergo autologous reconstruction and receive pedicled, over free flap, reconstruction at significantly higher rates than privately-insured patients.

Meaning: Despite extensive legislation aimed to protect women's ability to undergo autologous and implant-based breast reconstruction, insurance status significantly influences breast reconstruction in the United States.

Inclusion and Exclusion Criteria

International Classification of Diseases Ninth (ICD-9) and Tenth Revision (ICD-10) Clinical Modification and Procedure Coding System (PCS) codes were used to identify patients who underwent either autologous- or implant-based breast reconstruction during the selected four-year period (See appendix, Supplemental Digital Content 1, which displays the International Classification of Diseases Ninth (ICD-9) and Tenth Revision (ICD-10) Clinical Modification (CM) and Procedure Coding System (PCS) Codes. <http://links.lww.com/PRSGO/C404>.)

Patients who underwent pedicled flaps [ie, latissimus dorsi or transverse rectus abdominus myocutaneous (TRAM) flaps] with concurrent implant placement were considered to be autologous-based reconstruction patients. Patients who underwent unspecified breast reconstruction modalities (ICD 9 PCM 85.70, 85.79) were excluded from analysis as details of their reconstructions could not be determined. As the HCUP database only contains data from hospital admissions, no outpatient breast reconstruction data was analyzed.

Patient and Hospital Variables

A total of 31,468 patients were identified for inclusion and analyzed according to variables provided by the HCUP NIS Database. Patients were further stratified based on their demographics, comorbidities, surgical procedures, insurance payer, and socioeconomic status. Patient's household income is based upon data derived from Claritas and is updated yearly. As such, the ranges for this data vary from year to year and were classified by quartile. In addition to patient demographics, data were collected regarding the hospital characteristics where the surgery was performed, including bed size, region, teaching status, city characteristics, and ownership. All hospital characteristics were similarly provided by the HCUP NIS Database and were based off of the American Hospital Association Annual Survey of Hospitals.

Analysis

De-identified sociodemographic, insurance, and hospital data were analyzed using bivariate risk ratio testing,

forced entry multivariable logistic regression analysis, least absolute shrinkage selection operator (LASSO) regression analysis, and classification tree analysis. LASSO regression analysis was performed to identify associations between reconstructive modality and patient/hospital factors that may influence the reconstructive modality chosen. If a variable had five or fewer missing values, the rows containing those missing values were removed. Variables with five or more missing values were grouped together to prevent data loss. Odds ratios (ORs) with *P* less than 0.05 were considered significant for the logistic regression. LASSO regression *P* values were not evaluated because they are inherently biased. To give the reader further details regarding patient demographics, Medicare and Medicaid insurance subcategories were included in the descriptive statistics section of the article. This subcategorization was omitted in the regression to optimize model simplicity. Classification tree analysis was performed in order to easily visualize the most important factors that may influence the reconstructive modality. LASSO regression and classification tree analysis were performed with *R* 3.5.0 (*R* Core Team, 2020). All other statistical analyses were performed using IBM SPSS Statistics, version 27 (IBM Corp., Armonk, N.Y.).

RESULTS

Patient Demographics and Hospital Characteristics

From 2014 to 2017, the HCUP NIS database registered 31,468 autologous- and implant-based breast reconstruction procedures. The average breast reconstruction patient was 51.5 years old and White (70.9%). Most breast reconstruction patients, regardless of reconstructive modality, resided in zip codes in the top quartile of incomes (38.9%) and underwent reconstruction in the South (35.8%). In regard to comorbidities, the vast majority of patients undergoing breast reconstruction were nonsmokers (97.4%), nonobese (90.3%), and normotensive (75.5%) (Tables 1 and 2). Most breast reconstructions were performed in private (79.5%), large bed size (57.4%), urban-teaching hospitals (81.6%), located in either “fringe” or “central” counties of metropolitan areas with populations of more than 1 million people (66.9%).

Reconstruction Modality

The majority of patients undergoing breast reconstruction from 2014 to 2017 underwent non-autologous reconstruction (56.1%). Of the autologous reconstructions, deep inferior epigastric perforator (DIEP) flaps were the

Table 1. Patient Sociodemographic Data Stratified by Reconstruction Type

	Autologous		Nonautologous		Total		<i>P</i>
	n	%	n	%	n	%	
Number of patients	13,803	43.9	17,665	56.1	31,468	100.0	
Age, y (average)	51.82		51.26		51.47		
Gender	67	0.5	18	0.1	85	0.3	<0.001
Men							
Women	13,711	99.5	17,606	99.9	31,317	99.7	
Race							<0.001
White	9058	68.5	12,197	72.8	21,255	70.9	
Black	1878	14.2	1645	9.8	3523	11.8	
Hispanic	1268	9.6	1466	8.8	2734	9.1	
Asian or Pacific Islander	464	3.5	727	4.3	1191	4.0	
Native American	27	0.2	37	0.2	64	0.2	
Other	531	4.0	676	4.0	1207	4.0	
Median income of patient zip code							<0.001
Quartile 1	2456	18.1	2387	13.7	4843	15.6	
Quartile 2	2794	20.6	3305	19.0	6099	19.7	
Quartile 3	3529	26.0	4443	25.6	7972	25.8	
Quartile 4	4793	35.3	7249	41.7	12,042	38.9	
Region							<0.001
Northeast	2894	21.0	5435	30.8	8329	26.5	
Midwest	2310	16.7	3168	17.9	5478	17.4	
South	6108	44.3	5166	29.2	11,274	35.8	
West	2491	18.0	3896	22.1	6387	20.3	
Tobacco use							<0.001
Smoker	283	2.1	525	3.0	808	2.6	
Nonsmoker	13,520	97.9	17,140	97.0	30,660	97.4	
Obesity							<0.001
Obese	1615	11.7	1439	8.1	3054	9.7	
Nonobese	12,188	88.3	16,226	91.9	28,414	90.3	
Hypertension							<0.001
Hypertensive	3641	26.4	4066	23.0	7707	24.5	
Normotensive	10,162	73.6	13,599	77.0	23,761	75.5	

Table 2. Patient Sociodemographic Information Stratified by Insurance Type

	Medicare		Medicaid		Private Insurance		Other		Total		P
	n	%	n	%	n	%	n	%	n	%	
No. patients	4226	13.4	3110	9.9	22,756	72.3	1346	4.3	31,467	100	
Age, y (average)	65.12		46.98		49.9		51.5				
Gender											<0.001
Men	27	0.6	10	0.3	34	0.1	13	1.0	84	0.3	
Women	4195	99.4	3095	99.7	22,675	99.9	1324	99.0	31,289	99.7	
Race											<0.001
White	3083	76.0	1450	48.8	15,965	73.8	738	57.7	21,236	70.9	
Black	503	12.4	600	20.2	2224	10.3	190	14.8	3517	11.7	
Hispanic	282	6.9	619	20.8	1639	7.6	194	15.2	2734	9.1	
Asian or Pacific Islander	77	1.9	146	4.9	892	4.1	76	5.9	1191	4.0	
Native American	9	0.2	9	0.3	42	0.2	4	0.3	64	0.2	
Other	105	2.6	149	5.0	874	4.0	78	6.1	1206	4.0	
Median income of patient zip code											<0.001
Quartile 1	838	20.2	949	31.3	2823	12.6	223	17.27	4833	15.6	
Quartile 2	936	22.6	739	24.3	4127	18.4	292	22.62	6094	19.7	
Quartile 3	1066	25.7	712	23.5	5856	26.1	332	25.72	7966	25.8	
Quartile 4	1300	31.4	636	20.9	9654	43.0	444	34.39	12,034	38.9	
Region											<0.001
Northeast	1023	24.2	1036	33.3	5967	26.2	291	21.6	8317	26.5	
Midwest	765	18.1	468	15.0	4087	18.0	156	11.6	5476	17.4	
South	1560	36.9	843	27.1	8268	36.3	588	43.7	11,259	35.8	
West	878	20.8	764	24.6	4434	19.5	311	23.1	6387	20.3	
Tobacco use											<0.001
Smoker	119	2.8	148	4.8	502	2.2	39	2.9	808	2.6	
Nonsmoker	4107	97.2	2963	95.2	22,254	97.8	1307	97.1	30,631	97.4	
Obesity											<0.001
Obese	442	10.5	355	11.4	2140	9.4	113	8.4	3050	9.7	
Nonobese	3784	89.5	2756	88.6	20,616	90.6	1233	91.6	28,389	90.3	
Hypertension											<0.001
Hypertensive	1894	44.8	787	25.3	4748	20.9	270	20.1	7699	24.5	
Normotensive	2332	55.2	2324	74.7	18,008	79.1	1076	79.9	23,740	75.5	

Table 3. Breast Reconstruction Modality Stratified by Insurance Type

	Medicare		Medicaid		Private Insurance		Other (Self Pay/No Charge/Other)		Total		P		
	n	%	n	%	n	%	n	%	n	%			
	Nonautologous												
Tissue expander			2320	73.2	1787	79.7	12,453	77.1	660	67.2	17,220	76.4	<0.001
Implant			849	26.8	456	20.3	3702	22.9	322	32.7	5329	23.6	<0.001
Autologous													
Latissimus dorsi myocutaneous flap			998	52.8	563	39.2	3068	29.5	212	35.5	4841	33.8	<0.001
TRAM flap			358	18.9	338	23.5	1790	17.2	123	20.6	2609	18.2	<0.001
DIEP flap, free			494	26.1	510	35.5	5277	50.8	251	42.0	6532	45.6	<0.001
Superficial inferior epigastric artery (SIEA) flap, free			27	1.4	21	1.5	192	1.8	9	1.5	249	1.7	0.331
Gluteal artery perforator (GAP) flap, free			13	0.7	6	0.4	69	0.7	3	0.5	91	0.6	0.722

most common, (45.6%), followed by latissimus dorsi myocutaneous flaps (33.8%). Autologous flap choice varied by insurance payer ($P < 0.001$), with the majority of privately-insured autologous patients undergoing DIEP flap reconstruction (50.8%), while the majority of Medicare patients underwent latissimus dorsi flap reconstruction (52.8%) (Table 3).

Bivariate Analysis

Risk ratio analysis revealed several significant differences in the autologous breast reconstruction subgroup when stratified by either private or public insurance payer status. Publicly-insured patients were 2.09 times as likely to undergo pedicled reconstruction (ie, pedicled TRAM or latissimus dorsi reconstruction) when compared with

Table 4. Logistic and LASSO Models Predicting Autologous-based Breast Reconstruction

	Logistic Regression Coefficient	LASSO Coefficient	Logistic Regression Odds Ratio	LASSO Odds Ratio	Logistic Regression, <i>P</i>
Insurance					
Private	—	—	1.000	1.000	—
Public	-0.056	-0.049	0.946	0.952	0.047
Race					
White	—	—	1.000	1.000	—
Black	0.285	0.284	1.330	1.328	<0.001
Hispanic	0.084	0.081	1.088	1.084	0.043
Asian or Pacific Islander	-0.121	-0.113	0.886	0.893	0.049
Native American	-0.022	0.000	0.978	1.000	0.931
Other	0.049	0.041	1.050	1.042	0.415
Income quartile					
1	—	—	1.000	1.000	—
2	-0.146	-0.126	0.864	0.882	<0.001
3	-0.220	-0.197	0.803	0.821	<0.001
4	-0.391	-0.368	0.677	0.692	<0.001
Hospital location and teaching status					
Rural	—	—	1.000	1.000	—
Urban nonteaching	0.311	0.169	1.365	1.185	0.008
Urban teaching	0.864	0.726	2.372	2.067	<0.001
Smoking status					
Nonsmoker	—	—	1.000	1.000	—
Smoker	-0.388	-0.376	0.678	0.686	<0.001
Obesity					
Nonobese	—	—	1.000	1.000	—
Obese	0.337	0.333	1.401	1.395	<0.001

Table 5. Logistic and LASSO Models Predicting Pedicle-based Autologous Reconstruction.

	Logistic Regression Coefficient	LASSO Coefficient	Logistic Regression Odds Ratio	LASSO Odds Ratio	Logistic Regression, <i>P</i>
Insurance					
Private	—	—	1.000	1.000	—
Public	0.675	0.652	1.965	1.920	<0.001
Race					
White	—	—	1.000	1.000	—
Black	-0.257	-0.204	0.774	0.816	<0.001
Hispanic	-0.238	-0.176	0.788	0.839	0.006
Asian or Pacific Islander	-0.411	-0.334	0.663	0.716	0.004
Native American	0.408	0.119	1.504	1.127	0.484
Other	-0.264	-0.185	0.768	0.831	0.074
Income quartile					
1	—	—	1.000	1.000	—
2	-0.015	0.012	0.985	1.012	0.847
3	-0.081	-0.017	0.922	0.983	0.282
4	-0.424	-0.366	0.655	0.693	<0.001
Hospital location and teaching status					
Rural	—	—	1.000	1.000	—
Urban nonteaching	-0.901	0.000	0.406	1.000	0.014
Urban teaching	-1.464	-0.573	0.231	0.564	<0.001
Smoking status					
Nonsmoker	—	—	1.000	1.000	—
Smoker	0.631	0.567	1.879	1.764	<0.001
Obesity					
Nonobese	—	—	1.000	1.000	—
Obese	-0.341	-0.301	0.711	0.704	<0.001

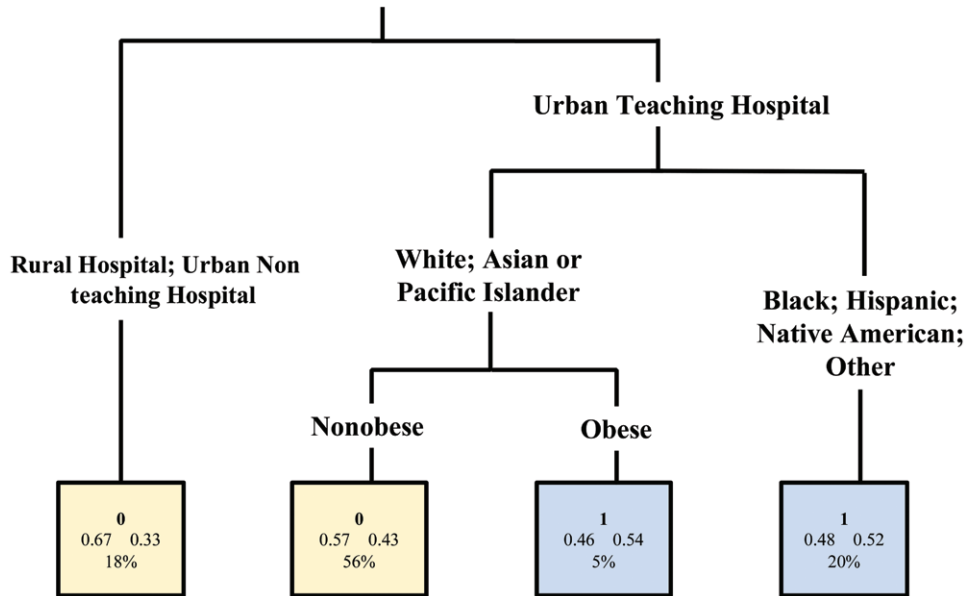


Fig. 1. Autologous- vs nonautologous-based breast reconstruction classification tree.

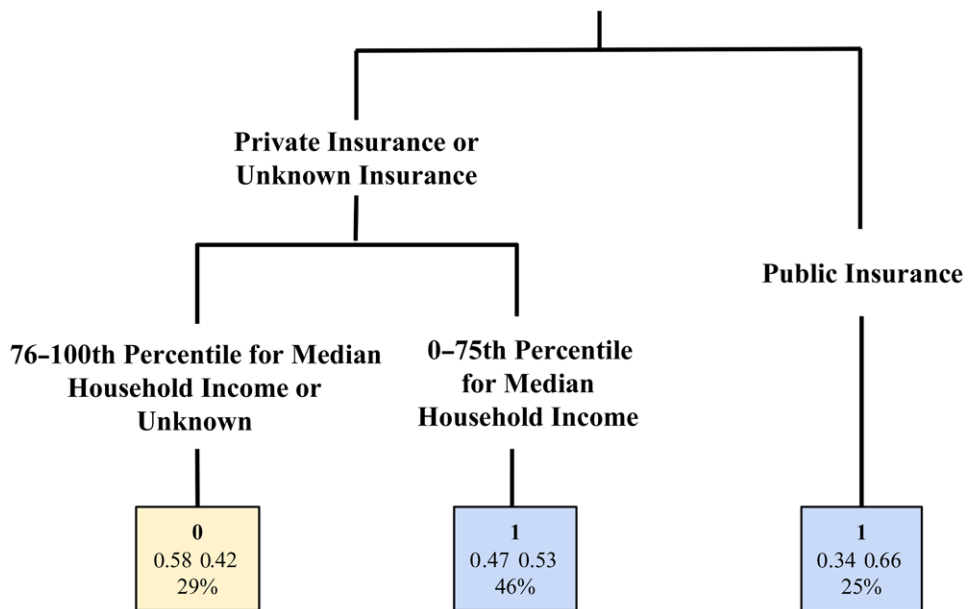


Fig. 2. Pedicled- vs free-flap-based breast reconstruction classification tree.

privately-insured patients [CI, 1.87–2.34]. Privately-insured patients were 1.93 times as likely to receive DIEP flap reconstruction when compared with publicly-insured patients [CI, 1.72–2.17].

Multivariate Logistic and LASSO Regression Predicting Autologous Reconstruction and Autologous Reconstruction Modality

Multivariable logistic and LASSO regression identified multiple factors of significance associated with an

increased likelihood of autologous-based reconstruction: private insurance status, Black race, Hispanic ethnicity, urban hospital location, nonsmoking status, and obesity. Increasing zip code income quartile was associated with decreased likelihood of autologous-based reconstruction. When analyzing insurance payer, both logistic and LASSO regression demonstrated that publicly-insured patients were significantly less likely to undergo autologous reconstruction than privately-insured patients (LASSO OR: 0.952/ Logistic OR: 0.946, *P* = 0.047) (Table 4).

When stratified by autologous reconstruction technique, multivariable logistic and LASSO regression identified that publicly-insured patients were more likely to obtain a pedicled flap than a free flap reconstruction (LASSO OR: 1.920/ Logistic OR: 1.965, $P < 0.001$). In regard to race, LASSO regression revealed that Black, Hispanic, and Asian/Pacific Islander patients were all significantly less likely to receive a pedicled flap as compared with White patients. Pedicle-based reconstruction was less likely to be performed in obese patients, but almost twice as likely to be performed in smokers. Urban teaching hospitals were significantly less likely to perform pedicle-based reconstruction when compared with rural hospitals (LASSO OR: 0.564, Logistic OR: 0.231, $P < 0.001$) (Table 5).

Classification and Regression Tree Diagrams

Classification and regression trees were created in order to identify important predictive factors for both autologous- and pedicle-based reconstruction. Autologous- or implant-based reconstruction was best predicted by the following three variables: (1) the location and teaching status of the hospital, (2) patient race, and (3) obesity status (Fig. 1). This tree correctly classified 56.9% of all patients. Of the patients who underwent autologous-based reconstruction, pedicled- versus free-flap-based reconstruction was best predicted by (1) insurance payer and (2) zip code quartile (Fig. 2). This simple algorithm correctly classified 54.6% of patients who had the autologous-based reconstructions.

DISCUSSION

Although breast reconstruction has long been perceived to be a choice guided by patient preference and anatomic constraints, previous studies have shown that many reconstructive decisions lie completely out of the patient's hands. Sociodemographic and hospital factors have previously been demonstrated to influence whether or not a patient undergoes any breast reconstruction whatsoever following mastectomy.^{4,10,11,13,14} Within the cohort of patients who undergo postmastectomy reconstruction, a disparity exists between privately- and publicly-insured patients, with privately-insured patients undergoing autologous reconstruction at significantly higher rates than Medicare and Medicaid patients.⁸ As no recent studies have analyzed the recent national impact of insurance payer on breast reconstruction, our study re-evaluated the impact of insurance payer on breast reconstruction 24 years after the advent of the Women's Health Care and Cancer Rights Act and a decade after the passage of the Affordable Healthcare Act.

Hospital and Surgeon Influence in Breast Reconstruction

In our study, most implant and autologous-based breast reconstruction occurred in large bed size, urban teaching hospitals. Our findings are consistent with previous literature which has identified a significant association

between urban teaching hospitals and autologous breast reconstruction.¹⁰ This association is of little surprise, as most urban teaching hospitals are large, tertiary referral centers harboring both breast surgery and reconstructive microvascular surgery services.

A previous survey of American Society of Plastic Surgery members identified multiple factors at the surgeon level itself which may contribute to our findings. Alderman et al found that the majority of high volume breast reconstructive surgeons are affiliated with multidisciplinary cancer centers, perform a greater proportion of autologous reconstruction than their moderate to lower volume counterparts, and have resident assistance. This American Society of Plastic Surgery survey data additionally revealed that high-volume breast reconstructive surgeons had the lowest perceived financial constraints as a result of third party reimbursement. This may be secondary to the fact that high-volume breast reconstructive surgeons have a more diverse insurance payer base, overall lower overhead costs, and lower reimbursement expectations than their low-volume, community-based peers.¹⁵ Additionally, high-volume surgeons may benefit from the ability to negotiate higher payments from private insurers, which is not an option within the public insurance realm nor often a reality for lower-volume surgeons. Regardless of volume, recent work by Panchal et al supports that as surgeon compensation increases, rates of microsurgical breast reconstruction increase, irrespective of insurance payer.¹⁶ As smaller hospitals and community plastic surgeons feel an increased need to perform high reimbursement, cost effective procedures, these factors may account for the hospital patterns observed in our study.

Finally, as autologous breast reconstruction requires significant resources both intraoperatively and postoperatively, it is logical that these operations are predominantly occurring in teaching hospitals. Relatively speaking, only a select group of surgeons across the nation have undergone the advanced microvascular training required to perform these procedures, and few local hospitals possess either the surgeons or resources required to perform free tissue transfer in a community-type setting.

Racial Disparities in Breast Reconstruction

Previous literature has clearly demonstrated a significant racial disparity in breast reconstruction in the United States, with Black women undergoing breast reconstruction at a significantly lower rate than White women, and even compared with other women of color. Recent work by Sergesketter et al has shown that although inequities continue to exist within absolute rates of breast reconstruction between racial subgroups, this gap may be narrowing, as minority women had the largest increase in rate of breast reconstruction of any racial subgroup from 1998 to 2014.¹⁷

In congruence with several recent studies, our analysis identified Black and Hispanic race/ethnicity as a predictor of autologous-based reconstruction.¹⁷⁻¹⁹ The predilection for autologous-based reconstruction amongst Black

and Hispanic women has previously been attributed to a higher average body mass index amongst minority patients; yet, recent work by Offodile et al revealed that Black and Hispanic race/ethnicity continued to predict autologous reconstruction even after adjusting for body mass index.¹⁹ As such, it has been postulated that the deep-seeded mistrust of the predominantly White medical establishment by Black patients may account for Black women's predilection for autologous-based reconstruction.^{18,19} In the wake of Tuskegee and other abuses of the American healthcare system, there exists a well-founded distrust of implanted and/or foreign materials within the African-American community, which may be reflected in postmastectomy reconstruction patterns observed.²⁰ In further support of this hypothesis was the finding that subgroup analysis of the autologous cohort showed that Black, Hispanic, and Asian/Pacific Islander patients are significantly less likely to receive pedicled reconstruction when compared with White patients (Table 5). As pedicled autologous reconstruction often requires the concurrent placement of an implant in order to provide adequate volume to the reconstruction, this finding may be a reflection of many minority women's desire to avoid implanted medical materials.²⁰

Reconstruction Modality by Insurance

Our data showed a significant difference in autologous reconstructive rates between privately-insured and publicly-insured patients. This may be a reflection of a national trend favoring implant-based over autologous reconstruction since 2002, as more surgeons begin to perform implant-based reconstruction even in the setting of postmastectomy radiation therapy.⁶ From 2005 to 2014, the proportion of mastectomy patients pursuing reconstruction increased from 33.2% to 60.0%, and the rate of autologous reconstruction decreased by approximately half.²¹ The growing popularity of prepectoral implant placement has likely contributed to this trend, as prepectoral placement has been shown to significantly decrease postoperative pain, obviates animation deformity, and offers a natural reconstruction appearance with the adjunct of fat grafting.²² Furthermore, studies have shown that autologous-based reconstruction costs significantly more per hour of operative time than immediate tissue expander-based reconstruction, further disincentivizing autologous-based reconstruction compared with implant-based reconstruction.²³⁻²⁵

Insurance status was found to be of great significance when subgroup analysis was performed on the autologous reconstruction cohort. When this subgroup was further analyzed by either free-flap or pedicle-based reconstruction, our study re-demonstrated the increased likelihood for privately-insured patients to undergo free-flap over pedicled reconstruction.^{8,10} Furthermore, our study demonstrated the association of insurance payer with flap subtype on a national level (Table 3). In our study, publicly-insured patients were 1.92 times more likely to undergo pedicled autologous reconstruction as compared with privately-insured patients. Although the introduction of DIEP flaps dramatically decreased the donor site morbidity incurred by pedicled TRAM and latissimus flaps,

this procedure is a significantly costlier and more time consuming surgery.^{24,26} Our study demonstrated that privately-insured patients were 1.54 times as likely to receive DIEP flap reconstruction as compared with publicly-insured patients.

Currently, private insurance carriers reimburse hospitals significantly more for perforator-based flaps over pedicle-based flaps via specialty codes S2066 to S2068, but in publicly-insured patients, the reimbursement is comparable.⁸ This financial discrepancy may account for the fact that in our study, the majority of privately-insured patients received DIEP flaps, whereas the majority of publicly-insured patients received TRAM flaps. As surgeons and their hospital systems are not compensated equally for free-flap-based reconstruction, surgeons may be biased toward using higher reimbursement procedures for privately-insured patients.

Despite extensive local and national level legislation aimed at expanding and equalizing women's ability to undergo breast reconstruction, clear disparities in post-mastectomy reconstruction continue to exist. Classification tree analysis of our dataset demonstrated that one can predict whether or not a patient will undergo autologous- or implant-based reconstruction by knowing only three variables: (1) the location and teaching status of the hospital, (2) patient race, and (3) obesity status (Fig. 1). Of the patients who underwent autologous reconstruction, pedicled versus perforator flap could be predicted knowing only (1) insurance payer and (2) zip code quartile (Fig. 2). As the majority of autologous-based reconstructions in our study occurred in urban teaching hospitals, it is clear that either conscious or subconscious bias exists in large academic institutions across our nation, with significant ramifications for patients who are less favorably insured or from lower socioeconomic backgrounds.

Although previous research has demonstrated the statistical significance of the surgeon in relation to predicting microvascular reconstruction modality,⁸ it is unclear if the disparity observed in our study originates at the surgeon level or is a result of influence from the hospital system itself. Additional research is necessary to determine through which mechanisms the disparities observed in this study are perpetuated, and how hospitals and surgeons can best approach mitigating future inequity for breast reconstruction patients. Shared decision protocols for breast reconstruction patients could potentially help lessen inherent bias and allow the patients to choose the reconstructive modality that they are most comfortable pursuing.

Limitations

Our study had multiple limitations. As our data were sourced from HCUP NIS databases and not derived from our own institutions' patients, we had to rely on the accuracy of ICD-9 and ICD-10 diagnosis and procedural coding from outside providers. Furthermore, significant shifts between ICD-9 and ICD-10 codes limited certain data analysis, such as the lack of differentiation between pedicled and free-TRAM flaps beginning with the implementation of ICD-10. The NIS database only reflects

inpatient hospital admissions, potentially limiting our analysis as implant-based reconstruction does not necessitate an inpatient academic hospital setting. Despite these limitations, the use of HCUP, or a similar database, was the only way to elucidate the national impact of insurance payer on breast reconstruction. Finally, breast reconstruction modality is a multifactorial decision that is significantly influenced by patient factors, surgeon, and institution bias; many of these factors cannot be captured in a dataset and may significantly influence the patterns observed.

CONCLUSIONS

Despite the reconstructive rights afforded to all patients via the Women's Health and Cancer Rights Act of 1998 and increased access to healthcare afforded by the enactment of the Affordable Care Act in 2010, significant breast reconstruction disparities continue to exist within the United States. Postmastectomy reconstruction modality is significantly influenced by insurance payer, and implant-based reconstruction is favored over autologous reconstruction for women who have public insurance coverage.

Justin M. Sacks, MD, MBA, FACS
660 South Euclid Avenue
Campus Box 8238
St. Louis, MO 63110
E-mail: jmsacks@wustl.edu

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