Published in final edited form as:

Ann Surg Oncol. 2019 January ; 26(1): 62–70. doi:10.1245/s10434-018-6825-7.

Regional Market Competition and the Use of Immediate Breast Reconstruction After Mastectomy

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Synopsis

Background—Prior work has shown that the competitiveness of the market in which hospitals operate is associated with use of surgical procedures. We examined the association between regional market competition and use of breast reconstruction in women with breast cancer and ductal carcinoma in-situ undergoing mastectomy.

Methods—Women who underwent mastectomy from 2010–2011 recorded in the National Inpatient Sample were selected. The competitive market environment for each hospital in which patients were treated was estimated using the Herfindahl-Hirschman Index (HHI). Multivariable models were developed to examine the association between regional market competition and breast reconstruction while adjusting for other clinical, demographic and structural variables.

Results—Among 22,011 women, immediate breast reconstruction was performed in 9902 (45.0%). The rate of immediate breast reconstruction was 34.5% in hospitals in non-competitive markets, 49.0% in moderately competitive markets, and 56.4% in highly competitive markets ($P<0.0001$). In a multivariable model, compared to women in non-competitive markets, women in moderately competitive markets were 24% (RR=1.24; 95% CI, 1.10–1.41) more likely to undergo immediate breast reconstruction while those in competitive markets were 25% (RR=1.25; 95% CI, 1.11–1.41). more likely to have reconstruction. Later year of treatment, higher census tract income level, and residence in an urban area were associated with an increased likelihood of reconstruction ($P<0.05$ for all). In contrast, older age, non-white race, and non-commercial insurance were associated with a lower likelihood of reconstruction ($P<0.05$ for all).

Conclusion—Patients who undergo mastectomy in hospitals in competitive markets are more likely to undergo immediate breast reconstruction.

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No other authors have any conflicts of interest or disclosures.

Keywords

Breast cancer; mastectomy; competition; regional variation

Introduction

For women undergoing mastectomy, immediate breast reconstruction offers a number of short- and long-term psychological benefits including improved self-esteem and body image and decreased levels of anxiety and depression.¹⁻⁴ Based on these benefits, it is recommended that women should be counseled about the benefits of reconstruction prior to undergoing mastectomy.⁵ These guidelines apply to women with invasive breast cancer undergoing mastectomy as well as to those with ductal carcinoma in situ (DCIS).

Despite the benefits of immediate breast reconstruction, studies have shown that the procedure is consistently underutilized.⁶⁻⁸ Among women with breast cancer who underwent mastectomy, the rate of reconstruction was only 27% in 2005 and rose steeply to 43% by 2014.⁶ Access to breast reconstruction remains a challenge and minority women and those with low socioeconomic status have particularly low rates of reconstruction.

In addition to clinical and demographic factors, there is growing recognition that the contextual environment in which a patient receives care influences the type of care rendered.⁹⁻¹¹ A hospital's underlying financial status as well as competitive market forces in which hospitals operate are two such factors.⁹⁻¹² Hospitals located in competitive market environments are more likely to offer technologically advanced and specialized treatments, sometimes including interventions that have not demonstrated efficacy.⁹⁻¹¹ The desire to increase market share is a likely factor in a hospital's decision to offer such treatments.

As the availability and use of immediate breast reconstruction may be one factor that influences patients' decision on where to undergo mastectomy, we hypothesized that hospitals located in competitive market environments would be more likely to offer immediate breast reconstruction, as women may be more likely to seek out breast cancer surgery at institutions where reconstructive surgeons who perform reconstruction are also available. The objective of this study was to examine the association between regional market competition and use of breast reconstruction in women with breast cancer and DCIS undergoing mastectomy.

Methods

Data sources and cohort

We utilized data from the National (Nationwide) Inpatient Sample (NIS) to identify women who underwent mastectomy. The NIS is a discharge database that captures a random sample of 20% of hospital discharges in the U.S. In 2010, NIS included data on approximately 8 million hospital stays from 45 states.¹³ Data on regional market competition was ascertained from the Hospital Market Structure (HMS) file which we linked to NIS.^{14,15} The HMS file includes data describing market competition that is updated every three years. Therefore, we used the data from 2009, and excluded the unlinked hospitals.

We selected women age 18 to 90 who underwent a mastectomy for invasive breast cancer or DCIS in 2010 and 2011 (Figure 1, Supplemental Table 1). Patients who had secondary malignancy to the breast were excluded.

Competitiveness Measures

We used Herfindahl-Hirschman Index (HHI) to measure hospital competition. HHI is a commonly accepted measure of market concentration.^{16–18} The HHI is calculated by summing the squared market shares of each hospital competing in the market and multiplied by 10,000. It is generally classified into four categories: <100 highly competitive, 100–1500 unconcentrated markets (competitive), 1500–2500 moderately concentrated, and >2500 highly concentrated markets (noncompetitive).¹⁸ Similar to prior work, as there were few hospitals with an HHI of <100 we classified hospitals with an HHI of <1500 as competitive markets.⁹

In the HMS file, a market can be defined by an area enclosed by a variable or fixed radius centered on the hospital, by patient flow, or by geopolitical boundaries. Each hospital's market share is calculated as its number of discharges divide by the total number of discharges from all hospitals in the market. As our primary measure of competition, we used the HHI with a variable radius definition that captures 75% of the hospital's discharges (radius 75% HHI). We performed additional sensitivity analyses using HHI defined by a 90% variable radius (capturing 90% of discharges), fixed radius (15-mile), patient flow (collection of patients' zip codes that accounts for 75%, 90% or 95% of a hospitals discharge), and geopolitical boundaries based on Metropolitan Statistical Areas (MSA), Health Service Areas (HSA), and Core-Based Statistical Areas (CBSA) and counties.

Patient and Hospital Characteristics

Patients were categorized based on receipt of immediate breast reconstructive surgery (flap or implant/tissue expander). The types of mastectomy (radical, simple, skin sparing) and performance of axillary lymph node dissection (ALND) was also noted (Supplemental Table 1). Demographic characteristics analyzed included year (2010–2011), age (<40, 40–49, 50–59, 60–69, 70–79, 80 years), race/ethnicity (white, black, Hispanic, other/unknown), income status (low <\$39,000, medium low \$39,000–\$47,999, medium high \$48,000–\$62,999, high \$63,000+, unknown), insurance status (Medicare, Medicaid, private, self-pay, other/unknown), and type of admission (urgent, elective, unknown). Comorbidity was measured using the Elixhauser comorbidity index classified as 0, 1, or 2. The hospitals were characterized by region (northeast, midwest, south, west), teaching status (teaching, non-teaching, unknown), bed size (small, medium, large, unknown), and location (rural, urban, unknown).

Statistical Analysis

Frequency distributions of patient- and hospital-characteristics were compared using χ^2 tests based on receipt of immediate breast reconstruction. We used mixed-effect log-Poisson regression model to evaluate the association between demographic characteristics and immediate breast reconstruction. The model included radius 75% HHI, breast cancer, mastectomy, axillary lymph node dissection, year, age, race/ethnicity, income and insurance

status, type of admission, comorbidity, hospital region, bed size, and location. Hospitals were included as a random-intercept to account for hospital-level clustering. Patients from hospitals with unknown bed size and location were excluded from the models because of multicollinearity. Similar models were developed to examine the sensitivity for different HHI measures while adjusting for the same set of demographic variables. All analyses were performed with SAS version 9.4 (SAS Institute Inc, Cary, North Carolina). All statistical tests were two-sided, and a p -value of <0.05 was considered statistically significant.

Results

Among 22,011 women, immediate breast reconstruction was performed in 9902 (45.0%) women while 12,109 (55.0%) did not undergo reconstruction. The rate of immediate reconstruction was 41.8% in those with invasive breast cancer and 64.4% in women with DCIS ($P<0.0001$) (Table 1). Performance of immediate breast reconstruction rose from 41.5% in 2010 to 48.2% in 2011 ($P<0.0001$).

In the unadjusted analysis, the rate of immediate breast reconstruction was 34.5% in hospitals in non-competitive markets, 49.0% at facilities in moderately competitive markets and 56.4% in highly competitive markets ($P<0.0001$). In a multivariable model, treatment at a hospital in a competitive regional market was associated with an increased likelihood of immediate breast reconstruction (Table 2). Compared to women treated in hospitals in a non-competitive market, women treated in moderately competitive markets were 24% ($RR=1.24$; 95% CI, 1.10–1.41) more likely to undergo immediate breast reconstruction while those treated in competitive markets were 25% ($RR=1.25$; 95% CI, 1.11–1.41). more likely to have reconstruction.

Women with DCIS were 20% ($RR=1.20$; 95% CI, 1.14–1.26) more likely to undergo immediate reconstruction than those with invasive cancer (Figure 2). Later year of treatment, higher census tract income level, and residence in an urban area were also associated with an increased likelihood of immediate reconstruction ($P<0.05$ for all). In contrast, older age, non-white race, and non-commercial insurance were associated with a lower likelihood of immediate breast reconstruction ($P<0.05$ for all).

These findings were robust in a number of sensitivity analyses (Supplemental Tables 2 and 3). When a 90% radius was used to define regional markets, the risk ratio for immediate reconstruction in competitive markets versus non-competitive markets was 1.39 (95% CI, 1.23–1.57). Similarly, using a fixed radius definition of competition, the risk ratio for immediate reconstruction in a competitive market was 1.21 (95% CI, 1.06–1.38). In contrast, there was no statistically significant association between competition and immediate breast reconstruction when patient flow as used as a metric for hospital competition.

Discussion

These data suggest that the regional market structure in which a hospital operates is associated with the likelihood of immediate breast reconstruction among women who undergo mastectomy. While only one third of women who underwent surgery in non-competitive markets received immediate reconstruction, the rate was over 50% at centers

operating in more competitive regional markets. The effect of market competition on access to reconstruction was independent of other clinical and demographic characteristics.

The competitive regional market in which a hospital operates appears to be an important influence on the allocation of care.^{9–11,19,20} We previously demonstrated that patients undergoing urologic and gynecologic surgery at a hospital in a competitive market were approximately 2–5 times more likely to undergo a robotic-assisted operation than those treated at hospitals in non-competitive markets. Similarly, use of endovascular surgery for aortic aneurysm repair and laparoscopy for colectomy were more common at hospitals in competitive regional markets.^{10,11} While market competition appears to be associated with the use of procedures and interventions, the relationship between market competition and quality of care has been inconsistent. While one report found that increased market competition was associated with decreased mortality for common medical conditions,²¹ other studies have suggested that the influence of hospital competition on quality of care is minimal.^{22,23}

Prior studies examining the influence of market competition on hospital services have predominantly explored the use of novel technologies and devices.^{9,11,19,24} Hospitals operating in competitive regional markets are more likely to offer technologically advanced treatments that are often of questionable benefit, a phenomenon coined the “medical arms race”.^{24–26} Provision of these services is likely geared towards marketing with an aim to increase market share. In contrast, our data suggest that regional competitive factors also influence the allocation of a treatment that is recommended and considered best practice. In some scenarios, market competition may promote adherence to evidence-based recommendations.²¹

Previous studies have found that a variety of clinical and demographic characteristics can influence the use of immediate reconstruction. Older age, black race, being married, residence in a rural area and greater medical comorbidity have all been associated with decreased likelihood of immediate breast reconstruction.^{7,8,27–29} Compared to women with commercial insurance, Medicaid recipients are 66% less likely to undergo breast reconstruction.²⁷ Hospital and surgeon factors also influence the performance of breast reconstruction. Similarly, patients treated by low volume surgeons and at low volume centers, women operated on by high volume surgeons and at high volume hospitals are more likely to undergo breast reconstruction.⁸ Patients treated at financially distressed hospitals are also less likely to undergo immediate breast reconstruction. In one analysis women who received care at hospitals classified as being under high financial distress were 20% less likely to undergo breast reconstruction than those at hospitals with low or no financial distress.¹² Our findings of an association between market competition and breast reconstruction were independent of other clinical and demographic characteristics.

While our study benefits from the inclusion of a large sample of patient and hospitals, we recognize a number of important limitations. First, we relied on the Herfindahl-Hirschman index as a surrogate for market competition. While the HHI has been widely utilized as a measure of competition in the evaluation of mergers and acquisitions as well as in studies of medical competition, we cannot exclude the possibility of misclassification of a small

number of hospitals. We performed a number of sensitivity analyses in which the definition of a market was varied to explore the validity of our findings. Second, we lack data on patient preferences and attitudes towards breast reconstruction. Third, while we corrected for a variety of clinical and demographic characteristics, there are undoubtedly unmeasured confounders that influenced the decision to perform immediate breast reconstruction. Lastly, while we identified an association between market competition and immediate breast reconstruction, this may be a surrogate for a variety of other factors that could have influenced the decision to perform reconstruction. For example, differences in the number of available plastic surgeons across different markets could explain a portion of the competition-based disparity that we noted.

Given the disparities in the utilization of breast reconstruction, there have been a number of initiatives to raise awareness about reconstructive options. A number of legislative initiatives have been enacted to ensure that women undergoing mastectomy have access to breast reconstruction. The Women's Health and Cancer Rights Act of 1998 requires group health plans to cover mastectomy to include coverage for reconstructive surgery.³⁰ In 2010, New York State passed legislation mandating that providers discuss reconstruction options with patients undergoing mastectomy. One study found that reconstruction rates in New York state increased after implementation of this legislation, particularly among minority patients and women with lower socioeconomic status.³¹

These data highlight the importance of contextual factors in the performance of immediate breast reconstruction for women undergoing mastectomy. While competitive market forces are unlikely to change, these findings suggest that a greater understanding of why women receiving care in non-competitive markets are less likely to undergo reconstruction is needed. One plausible explanation is that access to reconstructive surgeons or hospitals that perform reconstruction are limited in non-competitive market regions. A number of studies have shown that the rate of immediate breast reconstruction is correlated with the density of plastic surgeons in a given geographic region.³²⁻³⁴ Further, rural regions and areas with a higher percentage of older patients have a lower concentration of plastic surgeons that may exacerbate racial and socioeconomic disparities in breast reconstruction.^{32,34} Increasing the availability of plastic surgeons, or alternatively, selective referral of patients to other centers may improve the use of reconstruction in this scenario.

Alternatively, hospitals and surgeons in non-competitive regions may preferentially prioritize other more profitable procedures when there is no competitive pressure to offer breast reconstructive surgery. In this scenario, programs and policies to promote reconstruction targeted towards patients, providers, and hospitals may help to raise awareness. Similarly, increasing reimbursements for breast reconstruction or linking reimbursement for mastectomy to reconstruction may help to increase access to breast reconstruction.¹²

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

Dr. Wright has served as a consultant for Tesaro and Clovis Oncology. Dr. Neugut has served as a consultant to Pfizer, Teva, Eisai, Otsuka, and United Biosource Corporation. He is on the medical advisory board of EHE, Intl.

Dr. Wright (NCI R01CA169121-01A1) is a recipient of a grant and Dr. Tergas is the recipient of a fellowship (NCI R25 CA094061-11) from the National Cancer Institute. Dr. Hershman is the recipient of grants from the Breast Cancer Research Foundation, the Conquer Cancer Foundation and the Susan Komen Foundation.

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Synopsis

Patients who undergo mastectomy in hospitals in competitive markets are more likely to undergo immediate breast reconstruction.

Figure 1.
Flowchart of cohort selection.

Figure 2.
Adjusted relative risk of hospital factors associated with immediate breast reconstruction.

Table 1.

Demographic characteristics of patients and hospitals.

	Immediate breast reconstruction				P-value
	No		Yes		
	N	(%)	N	(%)	
All	12,109	(55.0)	9,902	(45.0)	
Breast cancer					<0.001
Invasive breast cancer	11,002	(58.2)	7,896	(41.8)	
DCIS	1,107	(35.6)	2,006	(64.4)	
Mastectomy					<0.001
Radical	258	(60.3)	170	(39.7)	
Simple	11,718	(60.4)	7,680	(39.6)	
Skin sparing	133	(6.1)	2,052	(93.9)	
Axillary lymph node evaluation					<0.001
No	2,555	(44.4)	3,205	(55.6)	
Yes	9,554	(58.8)	6,697	(41.2)	
Year					
2010	6,156	(58.5)	4,370	(41.5)	
2011	5,953	(51.8)	5,532	(48.2)	
Age					<0.001
<40	453	(30.4)	1,035	(69.6)	
40–49	1,412	(30.6)	3,204	(69.4)	
50–59	2,359	(42.8)	3,157	(57.2)	
60–69	3,151	(61.7)	1,960	(38.3)	
70–79	2,899	(85.8)	480	(14.2)	
80	1,835	(96.5)	66	(3.5)	
Race/ethnicity					<0.001
White	7,610	(52.4)	6,926	(47.6)	
Black	1,332	(59.9)	891	(40.1)	
Hispanic	943	(58.6)	665	(41.4)	
Other/unknown	2,224	(61.0)	1,420	(39.0)	
Income status					<0.001
Low (<\$39,000)	3,136	(69.8)	1,358	(30.2)	
Medium low (\$39,000-\$47,999)	3,091	(63.9)	1,745	(36.1)	
Medium high (\$48,000-\$62,999)	3,132	(54.0)	2,663	(46.0)	
High (\$63,000+)	2,551	(39.2)	3,953	(60.8)	
Unknown	199	(52.1)	183	(47.9)	
Insurance status					<0.001
Medicare	6,158	(82.1)	1,347	(17.9)	
Medicaid	1,345	(66.3)	685	(33.7)	
Private	4,141	(35.5)	7,523	(64.5)	
Self-pay	164	(68.0)	77	(32.0)	

Immediate breast reconstruction					
	No		Yes		P-value
	N	(%)	N	(%)	
Other/unknown	301	(52.7)	270	(47.3)	
<i>Type of admission</i>					<0.001
Urgent	1,081	(69.8)	468	(30.2)	
Elective	9,131	(54.0)	7,773	(46.0)	
Unknown	1,897	(53.3)	1,661	(46.7)	
<i>Comorbidity</i>					<0.001
0	3,569	(42.2)	4,887	(57.8)	
1	3,527	(55.7)	2,809	(44.3)	
2	5,013	(69.4)	2,206	(30.6)	
<i>Hospital region</i>					<0.001
Northeast	971	(48.0)	1,052	(52.0)	
Midwest	3,206	(58.3)	2,292	(41.7)	
South	4,889	(55.4)	3,930	(44.6)	
West	3,043	(53.7)	2,628	(46.3)	
<i>Hospital teaching status</i>					<0.001
Non-teaching	6,473	(63.3)	3,753	(36.7)	
Teaching	5,430	(47.4)	6,027	(52.6)	
Unknown	206	(62.8)	122	(37.2)	
<i>Hospital bed size</i>					<0.001
Small	1,782	(59.1)	1,234	(40.9)	
Medium	3,048	(59.0)	2,115	(41.0)	
Large	7,073	(52.4)	6,431	(47.6)	
Unknown	206	(62.8)	122	(37.2)	
<i>Hospital location</i>					<0.001
Rural	1,511	(89.1)	184	(10.9)	
Urban	10,392	(52.0)	9,596	(48.0)	
Unknown	206	(62.8)	122	(37.2)	
<i>Herfindahl-Hirschman Index (HHI) ^I</i>					<0.001
>2500 (non-competitive)	6,239	(65.5)	3,291	(34.5)	
1500–2500 (moderately competitive)	2,230	(51.0)	2,143	(49.0)	
<1500 (highly competitive)	3,352	(43.6)	4,331	(56.4)	
Unknown	288	(67.8)	137	(32.2)	

^I Based on radius 75% definition of HHI.

Table 2

Multivariate model for predictors of receipt of immediate breast reconstruction.

	aRR
<i>Herfindahl-Hirschman Index (HHI) ¹</i>	
>2500 (non-competitive)	Referent
1500–2500 (moderately concentrated)	1.24 (1.10–1.41) *
<1500 (highly competitive)	1.25 (1.11–1.41) *
Unknown	0.94 (0.68–1.30)
<i>Breast cancer</i>	
Invasive breast cancer	Referent
DCIS	1.20 (1.14–1.26) *
<i>Mastectomy</i>	
Simple	Referent
Radical	1.14 (0.97–1.33)
Skin sparing	1.49 (1.41–1.58) *
<i>Axillary lymph node evaluation</i>	
No	Referent
Yes	0.87 (0.83–0.91) *
<i>Year</i>	
2010	Referent
2011	1.09 (1.02–1.16) *
<i>Age</i>	
<40	Referent
40–49	0.99 (0.92–1.06)
50–59	0.87 (0.81–0.94) *
60–69	0.71 (0.66–0.77) *
70–79	0.35 (0.31–0.40) *
80	0.09 (0.07–0.12) *
<i>Race/ethnicity</i>	
White	Referent
Black	0.87 (0.80–0.93) *
Hispanic	0.91 (0.83–0.99) *
Other/unknown	0.83 (0.77–0.90) *
<i>Income status</i>	
Low (<\$39,000)	Referent
Medium low (\$39,000–\$47,999)	1.08 (0.999–1.16)
Medium high (\$48,000–\$62,999)	1.10 (1.03–1.18) *
High (\$63,000+)	1.20 (1.12–1.30) *
Unknown	1.22 (1.04–1.44) *

aRR	
<i>Insurance status</i>	
Private	Referent
Medicare	0.74 (0.68–0.80) *
Medicaid	0.71 (0.65–0.77) *
Self-pay	0.64 (0.50–0.81) *
Other/unknown	0.87 (0.76–0.98) *
<i>Type of admission</i>	
Elective	Referent
Urgent	0.85 (0.76–0.95) *
Unknown	0.81 (0.67–0.96) *
<i>Comorbidity</i>	
0	Referent
1	0.97 (0.93–1.02)
2	0.88 (0.84–0.93) *
<i>Hospital region</i>	
Northeast	Referent
Midwest	1.03 (0.85–1.25)
South	0.95 (0.79–1.14)
West	1.00 (0.81–1.24)
<i>Hospital bed size</i>	
Small	Referent
Medium	1.03 (0.84–1.26)
Large	1.17 (0.97–1.41)
<i>Hospital location</i>	
Urban	Referent
Rural	0.38 (0.32–0.47) *

Mixed-effect log-Poisson model included breast cancer, mastectomy, ALND, year, age, race, income status, insurance status, type of admission, comorbidity, hospital region, hospital bed size, hospital location, and radius 75% HHI. Hospital identifier was included as random effect. Patients with unknown hospital teaching status, bed size and location were not included due to multicollinearity. Hospital teaching status was not included due to model convergence issue.

¹Based on radius 75% definition of HHI.

* P-value<0.05.

aRR: adjusted risk ratio