Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Jing Zhou Date

Impact of Regional Supply Factors on the Geographic Variation of Early-Stage Breast Cancer Surgical Use

By

Jing Zhou
Master of Science in Public Health

Health Policy and Management

Edmund R. Becker
Committee Chair

Janet R. Cummings
Committee Member

Laura M. Gaydos
Committee Member

Impact of Regional Supply Factors on the Geographic Variation of Early-Stage Breast Cancer Surgical Use

By

Jing Zhou

Bachelor of Science in Economics
China Pharmaceutical University
2012

Thesis Committee Chair: Edmund R. Becker, PhD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Health Policy and Health Services Research
2015

Abstract

Impact of Regional Supply Factors on the Geographic Variation of Early-Stage Breast Cancer Surgical Use

By
Jing Zhou

Breast conservation therapy (BCT) and mastectomy are the two primary surgical treatments for early-stage breast cancer. In 1990, the National Institutes of Health Consensus Development Conference recommended BCT as the primary surgical treatment for early-stage breast cancer, due to the similar survival rate and higher quality of life of BCT, compared to mastectomy. However, BCT is underutilized and remarkable disparity in surgical rate exists across regions in the U.S.. Neither hospital factors nor patient-level factors such as patient age, race/ethnicity, education, hospital size, and teaching hospital, explain the geographic variation as examined by prior studies. This study aims to examine the association between hospital referral region (HRR)-level supply factors, particularly HRR-level supply of radiation oncologists and plastic/reconstructive surgeons, and the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs. Multiple data sources were used to establish study samples: 2002-2011 Nationwide Inpatient Sample, 2000 Census, 2008-2012 5-year estimates American Community Survey, and 1996, 2006, and 2011 Dartmouth Health Atlas data. We employed a multivariate linear regression model for statistical analysis and conducted sensitivity analyses to examine the impact of using different years of HRR-level supply factors on the study results. The results showed that each additional radiation oncologists per 100,000 residents in HRRs can result in a 7.16 decrease in the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs ($P<0.05$). Further, the supply of plastic and reconstructive surgeon is not associated with the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs. This study contributes to existing literatures on examining early-stage breast cancer inpatient surgical care disparity from regional market supply perspective. Our findings also suggest that the supply disparity on radiation oncologists across regions may lead to the geographic variation on early-stage breast cancer surgical care at inpatient settings.

Table of Contents

List of Tables

List of Figures

Introduction

Significant regional variation in the use of surgical care exists in many common surgical procedures [1-8]. Studies have shown that physicians in the same region tend to practice consistently, but that practice decisions may vary across regions [6-8]. This phenomenon has been described as "surgical signature" [1, 3]. Different surgical rates impact patients' health outcomes, quality of life, and health care spending in different regions, especially when one procedure is considered superior to other alternatives [1, 2]. This variation, in turn, affects the environmental factors across regions, including technology diffusion, supply of specialists, and surgical training programs [1, 2]. Therefore, understanding the underlying causes for geographic variation in surgical care can improve patients' health outcomes, direct reallocation of health care resources, and help patients and surgeons make informed decisions.

Differential surgical rate across regions exist in the surgical care of early-stage breast cancer. Breast-conserving therapy (breast-conserving surgery with radiation, BCT) and mastectomy are the two primary surgical procedures for early-stage breast cancer treatment. While clinical guidelines recommended BCT as the primary surgical procedure, as opposed to mastectomy, BCT has been shown underutilized and remarkable disparity in surgical rate exists across regions [9-11]. To explore the causes for the surgical geographic variation of early-stage breast cancer, this study seeks to examine whether regional supply factors, particularly the supply of radiation oncologists and the supply of plastic and reconstructive surgeons, are associated with mastectomy surgical rate for early-stage breast cancer at inpatient setting across regions.

Literature Review

Early-Stage Breast Cancer Surgical Care and Its Geographic Variation in the U.S.

Breast cancer is the most common cancer and the second leading cause of death among women [12]. In 2010, over 200,000 new cases of breast cancer were diagnosed in the United States [13]. Among these newly diagnosed breast cancer cases, around 75% were diagnosed at an early-stage[14]. Early-stage diagnosis is based on the size of the tumor and whether the cancer has spread and refers to cancer at Stages I, IIA, IIB, and IIIA [15]. At these stages, cancers may have spread to nearby lymph nodes but not to distant parts of the body [16].

Breast conservation therapy (BCT) and mastectomy are two principal surgical treatments for early-stage breast cancer [17]. Mastectomy is a very invasive treatment in that it removes patients' entire breast [9]. On the contrary, BCT is more conservative - it comprises a combination of breast-conserving surgery (BCS) and radiation therapy, and only removes the cancerous area and a small amount of surrounding normal tissue [9, 17].

In 1921, the first experimental study of BCT was conducted on several early-stage breast cancer patients [17-19]. During that time, radical mastectomy was the primary surgical treatment for a number of decades[17]. The experimental study showed equal results of the new therapy to radical mastectomy [18]. Following this study, multiple prospective randomized trials further demonstrated that women with early-stage breast cancer who receive BCT have a similar 5-year survival rate compared to women who receive mastectomy, with no significant increase in recurrence rates [17, 20-22]. But compared with BCT patients, mastectomy patients were reported to have more disrupted lives as well as significantly lower scores in body image and sexual function [17, 19, 20]. Therefore, in 1990, the National Institutes of Health Consensus

Development Conference concluded that "breast conservation treatment (BCS followed by radiation therapy) is an appropriate method of primary therapy for the majority of women with stage I and II breast cancer and is preferable because it provides survival equivalent to total mastectomy and axillary dissection while preserving the breast [9]".

Despite this evidence of the benefits of BCT, there remains continued use of mastectomy and a lower than optimal percentage of early-stage breast cancer patients undergoing BCT. Data from Kentucky Cancer Registry showed that mastectomy rate increased 7.5% from 2005 to 2007[23]. Data from the National Cancer Database also indicated that in the past couple decades, the rate of BCT use increased only 16% among all the early-stage breast cancer treatment procedures, from 31% in 1992 to 47% in 2008 [10, 11]. Moreover, early-stage breast cancer surgical use has also been shown to vary significantly in different regions across the country. In 1992, BCT was more than twice as common in the Middle Atlantic states and New England than in the South Central states [24-27]; Study also found that from 1998 to 2007, 45.5% of women in Kentucky underwent mastectomy, as compared to 25% in California [23, 28].

Impact of Hospital and Patient Level Factors on the Geographic Variation

To explore the causes of continued use of mastectomy and the geographic variation in early-stage breast cancer surgical use, multiple studies have examined hospital level factors and patient level factors that associated with the rate of surgical use. Studies have shown that higher rates of BCT are associated with certain hospital characteristics, such as teaching status, and urbanicity. Teaching hospitals and large urban hospitals are often designated as academic medical centers, have more research programs, increased physician training, and are more likely to be able to provide radiation therapy services and reconstruction after mastectomy [29-32].

Radiation therapy services are essential to BCT and, therefore, increase the likelihood of BCT usage [29]. The supply of reconstruction services is another important factor that affects patients' decision of mastectomy, given that mastectomy with reconstruction is able to achieve the same quality of life as BCT[15]. Therefore, the impact of teaching hospitals on continued use of mastectomy across regions is still unclear.

Patient characteristics, including medium age, lower income and uninsured, are also related to the continued use of mastectomy [24, 27, 29, 33-35]. Women at medium age (between 45-64 years old) are more concerned with the recurrence of breast cancer and thus more likely to choose mastectomy [36]. Income is also likely to have a negative associated with continued mastectomy use because three-year median cost of BCT with radiation is significantly higher than that of mastectomy [37, 38]. A higher use of mastectomy is also shown among patients without insurance, compared to those with public or private insurance[29]. However, differences in hospital, physician, and patient characteristics only explain a small degree of regional variation in the surgical rate, substantial variation across regions still exists after adjustment for these factors [29].

Impact of the Area-Level Market Supply Factors on the Geographic Variation

In addition to hospital and patient-level factors, regional supply factors, particularly the supply of plastic and reconstructive surgeons and the supply of radiation oncologists, may be associated with the continued use of mastectomy and surgical rate of early-stage breast cancer. According to federal Women's Health and Cancer Rights Act (WHCRA) in 1998, group health plans, health companies, and Health Maintenance Organizations (HMOs) must cover inpatient mastectomy, and reconstruction following mastectomy[39]. As of 2015, 37 states have

developed their own laws on mastectomy and reconstruction coverage such as California, Delaware, Florida, and Minnesota[40]. The differences in the coverage under various health plans and regions might lead to a resource distribution disparity across regions, such as the supply of radiation oncologists and the supply of plastic and reconstructive surgeons. Evidence showed that patients who reside in areas with low density of radiation oncologists are more likely to receive mastectomy, thus increasing the rate of mastectomy use within these areas [29-32, 36]. On the contrary, patients living in regions with high supply of plastic and reconstructive surgeons may have a higher chance to receive mastectomy, given the increased affordability under the federal mandates for both mastectomy and reconstruction following mastectomy, and so increasing the rate of mastectomy use [41]. Therefore, the supply disparity on radiation oncologists and plastic and reconstructive surgeons may be able to explain the geographic variation on early-stage breast cancer surgical care.

No prior studies have looked whether hospital referral regions-level supply disparities are associated with early-stage breast cancer inpatient surgical treatment across HRRs. Hospital referral regions (HRRs) are the areas served by large tertiary care hospitals, as described in the Dartmouth Health Atlas Project [5]. Patients are often referred from smaller hospitals to a tertiary center for major operations, including oncology surgical treatments [36]. For early-stage breast cancer patients, they tend to get their treatment in a tertiary care setting [42]. Thus, HRRs would be an appropriate capture of region differences for breast cancer treatment.

This study addresses these gaps in the literature by examining the relationship between HRR-level supply factors, particularly the supply of radiation oncologists and the supply of plastic and reconstructive surgeons, and the rate of mastectomy use at inpatient settings within HRRs for the early-stage breast cancer treatment in the United States.

Methodology

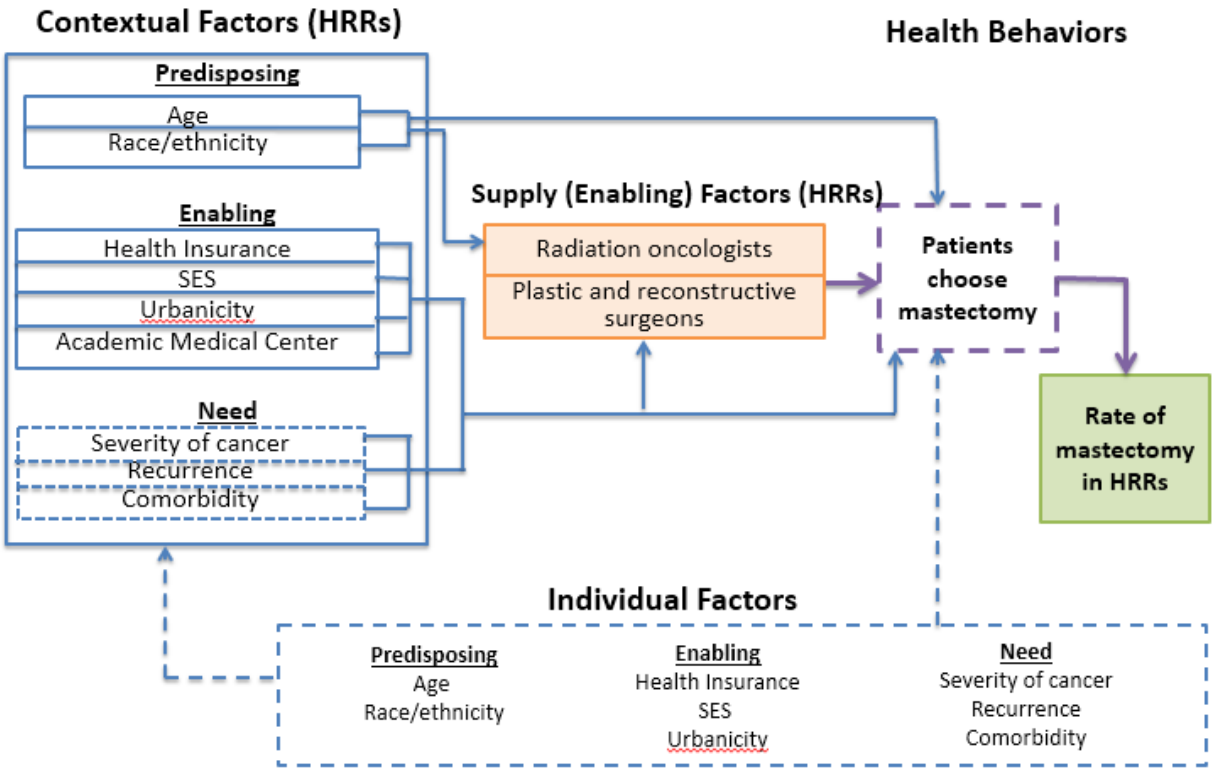
Conceptual Framework

To examine the relationship between HRR-level supply factors and the rate of mastectomy use at inpatient settings in HRRs for early-stage breast cancer treatment, this study used the Andersen and Aday Behavioral Model of Health Services Use as a conceptual framework[43]. This model emphasizes contextual, as well as individual, characteristics that affect health behavior (e.g., rate of mastectomy use) and health outcomes[43]. The three major components of contextual and individual characteristics are: predisposing, enabling and need-related factors[43]. Predisposing factors include demographic, social, and belief factors that might affect the likelihood of the need and use of health services for a community or an individual[43]. Enabling factors are defined as conditions that facilitate or impede health services use, and may include income, education level, and availability of health services facilities[43]. Need-related factors describe the health status of communities or individuals and the resulting need for services[43].

The orange box in the conceptual model represents the key independent variables: HRR-level supply of radiation oncologists and HRR-level plastic and reconstructive surgeons. The green box stands for the dependent variable: the rate of mastectomy use in HRRs for early-stage breast cancer at inpatient settings. Other contextual factors, such as HRR-level age, HRR-level race/ethnicity, HRR-level health insurance, HRR-level socioeconomic status (SES) and HRR-level hospital factors represented by white boxes, also impact the rate of mastectomy use across HRRs. Since this study mainly examines the impact of market-aggregated factors on the

geographic variation of surgical rate, individual factors, as shown in dotted box, are unmeasured. Contextual need-related factors, such as HRR-level health status, are also unmeasured for this study and are marked by a dotted box.

Figure 1. Conceptual model for the relationship between HRR-level supply factors and the rate of mastectomy use for early-stage breast cancer at inpatient settings



Sample

Data Sources

This study employed multiple data sources, including Nationwide Inpatient Sample, Census, Dartmouth Health Atlas, and American Community Survey, to construct the analytical dataset. Data about the rate of mastectomy use for early-stage breast cancer at inpatient settings within HRRs was provided by the 2002-2011 Nationwide Inpatient Sample (NIS). The NIS is a part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for

Healthcare Research and Quality (AHRQ)[44]. The NIS is the largest all-payer inpatient care database that is publicly available in the United States; it contains approximately 8 million hospital stays from about 1,000 hospitals[44]. The NIS is a 20 percent sample of discharges from hospitals participating in HCUP[44]. It also contains hospital weights and discharge weights that can be used to generalize the sample of hospital and discharge to the population of hospital and discharge in the U.S. [44]. We aggregated the NIS patient-level data into HRR-level data by hospital identifiers.

Data on the independent variables were obtained from the Dartmouth Health Atlas Project (DHA) hospital and physician capacity measures in 1996, 2006, and 2011. The DHA is designed to analyze how medical resources are distributed and used in the U.S. The project contains information and analysis about national, regional, and local markets, as well as hospitals and their affiliated physicians[45]. Data in the DHA are aggregated from three main sources: Census Current Population files, the Health Resources & Services Administration (HRSA) / American Medical Association medical file, and the HRSA Area Resource File[45].

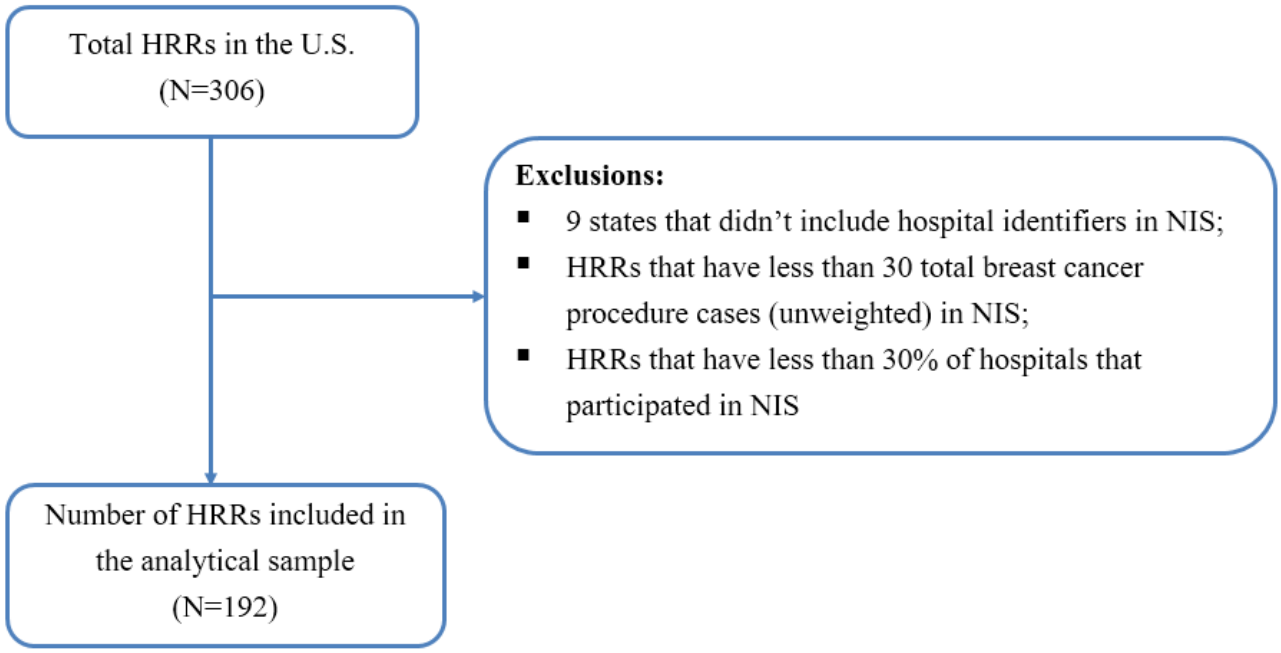
We drew contextual-level data on confounders from the 2000 U.S. Census data Summary Files and 2008-2012 5-year estimates American Community Survey (ACS) Summary File. Conducted by Census Bureau on April 1, 2000, census summary files are 100 percent data that include information on household, sex, age, and race for 281.4 million people across the country[46]. It also includes data on multiple small geographic units such as blocks, census tracts, and metropolitan areas[46]. The ACS is a nationwide mandate survey sent to a small portion of population on a rotating basis every year[47]. It includes information on demographic, social, economic, and housing[47]. The 5-year estimates of ACS includes 60 months of collected data

and represents the most reliable and largest sample size of ACS data[47]. Compared to 1-year estimates, the 5-year estimates are suitable for examining smaller geographic regions[47].

Study Sample

There are 306 HRRs in total in the U.S.. We excluded patients who live in the 9 states which didn't provide geographic identifiers, as these patients could not be aggregated into HRR-level data. To create a better and validate measure of the rate of mastectomy use, we also excluded HRRs that have less than 30 breast cancer procedure cases, or HRRs that have less than 30% of hospitals that participated in the NIS. As a result, we were able to include 192 HRRs in the analytical sample, representing 63% of all HRRs in the United States (Figure 2).

Figure 2. Flow chart of the study sample



Measures

HRR-level mastectomy rate

We aggregated the rate of mastectomy use for early-stage breast cancer at inpatient settings in the HRR from individual-level data into HRR-level data by zip-code. Within 2002-2011 NIS individual-level data, we included early-stage breast cancer female patients aged 18-85 in the United States. We used ICD-9-CM diagnostic codes (174.0 to 174.9 or 233.0) to identify breast cancer[48]. Patients with advanced stages of breast cancer (ICD-9-CM diagnostic codes: 196, 197, and 198) were excluded[48]. For patients diagnosed with early-stage breast cancer, we identified those who underwent mastectomy (ICD-9-CM codes: 85.41 to 85.47) [48]. To construct HRR-level rate of mastectomy use for early-stage breast cancer at inpatient settings, we used the weighted total number of inpatient mastectomy that performed for all the zip codes in the HRR divided the weighted total inpatient of early-stage breast cancer procedures that performed for all the zip codes in the HRR.

$$\textit{Percent of mastectomy use in the HRR for early-stage breast cancer at inpatient settings (weighted)} = \frac{\sum_{\substack{Number\ of\ mastectomy\ procedures \\ performed\ at\ each\ zip\ code\ in\ the\ HRR\ at\ inpatient\ settings(weighted)}}}{\sum_{\substack{Number\ of\ total\ early-stage\ breast\ cancer\ procedutures \\ performed\ at\ each\ zip\ code\ in\ the\ HRR\ at\ inpatient\ settings(weighted)}}}$$

HRR-level supply factors

Data for HRR-level supply factors came directly from the DHA hospital and physician capacity measures at HRR-level (Table 1). We used two continuous variables to measure the two independent variables: radiation oncologists per 100,000 residents in the HRR, and plastic and reconstructive surgeons per 100,000 residents in the HRR.

HRR-level predisposing factors

We used 2000 census data for HRR-level predisposing factors (i.e. HRR-level age and HRR-level race/ethnic). To distinguish the different effect of age groups on the breast cancer

treatment decision, we used four age groups to represent the age distribution of the populations within an HRR: percentage of people aged 18-45, 46-55, 56-64, and 65 and older in HRRs. Further, we constructed two continuous variables for the measure of HRR-level race/ethnicity: percentage of people who are white in the HRR, and percentage of people who are Hispanic in the HRR.

HRR-level enabling factors

To measure HRR-level enabling factors, we used data from 2000 census and 2008-2012 5-year estimates ACS. We constructed three continuous variables to describe HRR-level SES: HRR-level median household income, HRR-level percentage of college graduate, and HRR-level percentage of population are management, professional, or related occupations. We described health insurance as the proportion of people with private, public, or uninsured in HRRs.

We also controlled for HRR-level hospital and other factors using data from the DHA hospital and physician capacity measures. We measured HRR-level hospital factors as: the number of academic medical centers per 100,000 residents in the HRR, and percent of people live in urban areas in the HRR.

All these HRR-level predisposing and enabling factors were also aggregated from zip code level into HRR-level by zip code identifiers. We created the HRR-level percent of people aged 18-45 years old, we used the total number of people aged 14-45 of all the zip codes in the HRR divided the total number of people of all the zip codes in the HRR. Similar ways were used to construct all the other HRR-level predisposing and enabling factors, except HRR-level median household income. HRR-level median household income was constructed by the mean value of median household income of each zip code in the HRR.

$$Percent\ of\ people\ are\ white\ in\ the\ HRR =$$

$$\frac{\sum Number\ of\ white\ people\ at\ each\ zip\ code\ in\ the\ HRR}{\sum Total\ population\ at\ each\ zip\ code\ in\ the\ HRR}$$

$$\mathrm{HRR} - level\ median\ household\ income =$$

$$\frac{\sum Median\ household\ \ income\ at\ each\ zip\ code\ in\ the\ HRR}{Total\ zip\ codes\ in\ the\ HRR}$$

Table 1. Summary of variables measurement

Construct	Measure	Hypothesized relationship with DV	Data Sources
Dependent Variable: Early-stage breast cancer surgical rate			
HRR-level inpatient mastectomy rate	1 continuous/ratio variable: • The rate of mastectomy use for early-stage breast cancer at inpatient settings in the HRR	N/A	2002-2011 the NIS data
Independent Variables: Regional supply factors			
HRR-level supply of radiation oncologists	1 continuous/ratio variable: • Radiation oncologists per 100,000 residents in the HRR	The supply of radiation oncologists in the HRR is negatively associated with the DV	1996, 2006, and 2011 the DHA data
HRR-level supply of plastic and reconstructive surgeons	1 continuous/ratio variable: • Plastic and reconstructive surgeons per 100,000 residents in the HRR	The supply of plastic and reconstructive surgeons in the HRR is positively associated with the DV	1996, 2006, and 2011 the DHA data
Confounders			
HRR-level Age	4 continuous/ratio variables: • Percentage of people age 18-45 in the HRR • Percentage of people age 46-55 in the HRR • Percentage of people age 56-64 in the HRR • Percentage of people age 65 and older in the HRR	Percentage of people age 18-45, 65and older in the HRR has a negative and positive association with the DV, respectively	2000 the Census data
HRR-level	2 continuous/ratio variables:	Percentage of people who	2000 the

Race/ethnicity	• Percentage of people who are White in the HRR • Percentage of people who are Hispanic in the HRR	are White, Hispanic in the HRR has a negative and positive association with the DV, respectively	Census data
HRR-level Income	1 continuous/ratio variable: • Median household income of the HRR	Median household income of the HRR has a negative association with the DV	2000 the Census data
HRR-level Education	1 continuous/ratio variable: • Percentage of college graduate in the HRR	Percentage of college graduate in the HRR has a negative association with the DV	2000 the Census data
HRR-level Occupation	1 continuous/ratio variable: • Percentage of people are management, professional, or related occupations in the HRR	Percentage of people are management, professional, or related occupations in the HRR has a negative association with the DV	2000 the Census data
HRR-level Health insurance	3 continuous/ratio variables: • Percentage of people with private insurance in the HRR • Percentage of people with public insurance in the HRR • Percentage of people uninsured in the HRR	Percentage of people with private insurance in the HRR has a positive association with the DV	2008-2012 the ACS 5-year estimates
HRR-level urbanicity	1 continuous/ratio variable: • Percentage of people live in urban areas in the HRR	Percentage of people live in urban areas in the HRR has a negative association with the DV	2000 the census data
HRR-level hospital factor	1 continuous/ratio variable: Number of academic medical centers per 100,000 residents in the HRR	Number of academic medical centers per 100,000 residents in the HRR has a positive association with the DV	2006 the DHA data

Data Analysis

Research Questions and Hypotheses

Q_1: Is HRR-level supply of radiation oncologists associated with the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs?

H_1: After controlling for confounders, HRR-level supply of radiation oncologists has a negative association with the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs.

Q_2: Is HRR-level supply of plastic and reconstructive surgeons associated with the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs?

H_2: After controlling for confounders, HRR-level supply of plastic and reconstructive surgeons has a positive association with the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs.

Statistical Analysis

We conducted basic summary statistics to describe the characteristics of variables for this study. We also compared the summary statistics of the HRR-level supply factors in the year 1996, 2006, and 2011. Further, we used a multivariate linear regression model to test the two hypotheses (Model 1). We used HRR-level supply factors at the year 2006 as the independent variables for the main analysis, as 2006 is the middle year of the dependent variable, which is constructed by 2002 to 2011 data. We used SAS 9.3 (SAS Institute Inc, Cary, NC) for data analysis.

Model 1: $\mathbf{Yi = \beta_0 + \beta_1 Supply\ of\ radiation\ oncologists2006 + \beta_2 Supply\ of\ plastic\ and\ reconstructive\ surgeons2006 + \beta_3 Confounders + \varepsilon}$

Sensitivity Analysis

As HRR-level supply factors are only available at certain years, to examine whether the different years of HRR-level supply factors would affect our study results, we also conducted two sensitivity analyses. For the first sensitivity analysis, we used the mean values of the HRR-level supply factors at the year 2006 and 2011 as our independent variables (Model 2); for the

second sensitivity analysis, we used the mean value of HRR-level supply factors at the year 1996, 2006, and 2011 as our independent variables (Model 3). All the other study variables, as well as statistical methods, remained the same in the sensitivity analysis as in the primary analysis. Sensitivity analyses would allow us to test the validity of our study results as the changes of HRR-level supply factors at different years.

Model 2: **$Yi = \beta_0 + \beta_1$Supply of radiation oncologists1 $+ \beta_2$Supply of plastic and reconstructive surgeons1 $+ \beta_3$Confounders$+\varepsilon$**

[Supply of radiation oncologists1= Supply of radiation oncologists2006+ Supply of radiation oncologists2011)/2; Supply of plastic and reconstructive surgeons1= Supply of plastic and reconstructive surgeons2006+Supply of plastic and reconstructive surgeons2011)/2]

Model 3: **$Yi = \beta_0 + \beta_1$Supply of radiation oncologists2 $+ \beta_2$Supply of plastic and reconstructive surgeons2$+ \beta_3$Confounders$+\varepsilon$**

[Supply of radiation oncologists2= (Supply of radiation oncologists1996+Supply of radiation oncologists2006+ Supply of radiation oncologists2011)/3; Supply of plastic and reconstructive surgeons2= (Supply of radiation oncologists1996+Supply of plastic and reconstructive surgeons2006+Supply of plastic and reconstructive surgeons2011)/3]

Results

Descriptive Analysis

As shown in Table 2, from 2002 to 2011, the average rate of mastectomy use for early-stage breast cancer at inpatient settings in the HRRs was 74.11%, ranging from 51.52% to 97.30% across HRRs. The average supply of radiation oncologists per 100,000 residents in HRRs was 1.09, 1.19, and 1.17 in 1996, 2006, and 2011, respectively. The average supply of plastic and reconstructive surgeons per 100,000 residents in HRRs was 1.82, 1.82, and 1.78 in 1996, 2006, and 2011, respectively.

In 2000, the highest average median household income in HRRs was 83,321 dollars, while the lowest was only 24,102 dollars. In average, 14.02% of population aged 25 and older were graduated from college or higher degrees in HRRs, and 32.75% of population aged 18 and older were management, professional, or related occupations in HRRs. For population based demographic characteristics in HRRs, the percent of population aged 65 and older in HRRs ranged from 7.04% to 35.68%; the percent of population are White in HRRs ranged from 31.13% to 97.65%; the percent of population are Hispanic HRRs ranged from 0.59% to 50.06%. For population based health insurance status, the average percent of population that have any private insurance, public insurance, and uninsured in HRRs were 68.60%, 27.44%, and 13.47%, respectively. The number of medical center per 100,000 residents in HRRs ranged from 0.47 to 6.96.

Table 2. Descriptive statistics for the analytical sample (N=192)

Variables	Mean (Range)
Dependent variable	
Rate of mastectomy use in the HRR for early-stage breast cancer at inpatient settings (weighted) (%)	74.11(51.52-97.30)
Independent variables	
Supply of radiation oncologists	
Radiation oncologists per 100,000 residents in the HRR (1996)	1.09(0.11-2.34)
Radiation oncologists per 100,000 residents in the HRR (2006)	1.19(0.44-2.50)
Radiation oncologists per 100,000 residents in the HRR (2011)	1.17(0.31-2.42)
Supply of plastic and reconstructive surgeons	
Plastic and reconstructive surgeons per 100,000 residents in the HRR (1996)	1.84(0.30-5.10)
Plastic and reconstructive surgeons per 100,000 residents in the HRR (2006)	1.86(0.66-4.28)
Plastic and reconstructive surgeons per 100,000 residents in the HRR (2011)	1.82(0.48-4.31)
Covariates	
Age	
Percent of people aged 18 to 44 in the HRR (%)	38.75(25.12-47.30)
Percent of people aged 45 to 54 in the HRR (%)	13.56(8.42-16.15)
Percent of people aged 55 to 64 in the HRR (%)	8.99(5.16-13.11)
Percent of people 65 or older in the HRR (%)	13.72(7.04-35.68)
Race/ethnicity	
Percent of people are White in the HRR (%)	81.55(31.13-97.65)
Percent of people are Hispanic in the HRR (%)	9.68(0.59-50.06)
Socioeconomic status	
Median household income in the HRR ($)	43,244(24,102-83,321)
Percent of college graduate and above in the HRR (%)	13.93(7.37-28.72)
Percent of people are management, professional, or related occupations in the HRR (%)	32.60(22.01-53.07)
Health insurance	
Percent of people have any private health insurance in the HRR (%)	68.60(44.86-83.67)
Percent of people have any public health insurance in the HRR (%)	27.44(9.50-44.44)
Percent of people uninsured in the HRR (%)	13.47(3.57-28.04)
Urbanicity	
Percent of people live in urban area in the HRR (%)	73.67(25.87-100.00)
Hospital characteristics	
Number of academic medical center per 100,000 residents in the HRR	1.66(0.47-6.96)

Statistical Analysis

We adjusted for covariates, such as population based age, race/ethnicity, health insurance status, urbanicity, and hospital characteristics in the HRR, to examine the relationship between rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs and the two supply factors (the supply of plastic and reconstructive surgeons, and the supply of radiation oncologists) in the HRR (Table 3). Consistent with our hypothesis, the supply of radiation oncologists per 100,000 residents in HRRs is negatively associated with rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs ($p<0.05$). For each additional unit of radiation oncologists per 100,000 residents in HRRs, we can expect that the rate of mastectomy use in HRRs for early-stage breast cancer at inpatient settings to decrease by an average of 7.16.

Several HRR-level age factors are also are also significantly associated with the rate of mastectomy use for early-stage breast cancer at inpatient settings in HRRs, for example, each additional increase of the percent of population aged 45 to 54, the rate of mastectomy use for early-stage breast cancer at inpatient settings would decrease by 1.64 in the HRR ($p<0.05$); but as the percent of population aged 55 to 64 in the HRR increase by one percent, the rate of mastectomy use for early-stage breast cancer at inpatient settings would decrease by 3.08 ($p<0.05$). For HRR-level socioeconomic status, a decreasing of 0.76 in rate of mastectomy use for early-stage breast cancer at inpatient settings accounts for one per increase in the percent of residents are management, professional, or related occupations in the HRR ($p<0.05$). For hospital factor, we found that one unit increase in the number of academic medical centers per 100,000 residents in HRRs accounts for 3.47 increase in the rate of mastectomy use for early-stage breast cancer at inpatient settings ($p<0.05$).

Table 3. Multivariate regression analysis for the association of HRR-level supply factors and the rate of mastectomy use for early-stage breast cancer at inpatient settings (N=192)

Variables	Coefficients	P-value
Independent variables		
Radiation oncologists per 100,000 residents in the HRR (2006)	-7.160	0.000***
Plastic and reconstructive surgeons per 100,000 residents in the HRR (2006)	-1.326	0.232
Covariates		
Age		
Percent of people aged 18 to 44 in the HRR	-0.158	0.703
Percent of people aged 45 to 54 in the HRR	-1.643	0.050***
Percent of people aged 55 to 64 in the HRR	3.078	0.029***
Percent of people 65 or older in the HRR	-0.747	0.130
Race/ethnicity		
Percent of people are white in the HRR	0.080	0.320
Percent of people are Hispanic in the HRR	0.183	0.061
Socioeconomic status		
Median household income ($1,000) in the HRR	-0.239	0.060
Percent of college graduate and above in the HRR	0.011	0.980
Percent of people are management, professional, or related occupations in the HRR	0.755	0.019***
Health insurance		
Percent of people have any private health insurance in the HRR	0.832	0.191
Percent of people have any public health insurance in the HRR	0.517	0.423
Percent of people uninsured in the HRR	0.723	0.349
Urbanicity		
Percent of people live in urban area in the HRR	-0.041	0.489
Hospital characteristic		
Number of academic medical centers per 100,000 residents in the HRR	3.469	0.027***

***p<0.05

Sensitivity Analysis

Table 4 showed the results of sensitivity analyses. In sensitivity analysis 1, we used the average values of the HRR-level supply factors in 2006 and 2011 as the independent variables,

while sensitivity analysis 2 represents the independent variables of the mean of the HRR-level supply factors in 1996, 2006, and 2011. The sensitivity analysis results are very similar to the main results of using the 2006 HRR-level supply factors. Each additional radiation oncologists per 100,000 residents in the HRR would decrease the rate of mastectomy use for early-stage breast cancer at inpatient settings by 6.63 and 5.83 in sensitivity analysis 1 and sensitivity analysis 2, respectively ($p<0.05$). The supply of plastic and reconstructive surgeons per 100,000 residents in HRRs is still not significantly associated with the rate of mastectomy use for early-stage breast cancer at inpatient settings. Further, other covariates are significantly associated with the rate of mastectomy use for early-stage breast cancer at inpatient settings in the main analysis remain significant in the sensitivity analyses, and the magnitudes are of high similarity.

Table 4. Sensitivity analysis results (N=192)

	Main analysis		Sensitivity analysis 1		Sensitivity analysis 2	
Variables	**Coefficients**	**P-value**	**Coefficients**	**P-value**	**Coefficients**	**P-value**
Independent variables						
Radiation oncologists per 100,000 residents in the HRR	-7.160	0.000***	-6.634	0.002***	-5.830	0.013***
Plastic and reconstructive surgeons per 100,000 residents in the HRR	-1.326	0.232	-2.006	0.100	-1.917	0.141
Covariates						
Age						
Percent of people aged 18 to 44 in the HRR	-0.158	0.703	-0.179	0.668	-0.168	0.690
Percent of people aged 45 to 54 in the HRR	-1.643	0.050***	-1.655	0.051	-1.704	0.048***
Percent of people aged 55 to 64 in the HRR	3.078	0.029***	3.210	0.024***	3.348	0.020***
Percent of people 65 or older in the HRR	-0.747	0.130	-0.733	0.140	-0.761	0.132
Race/ethnicity						
Percent of people are white in the HRR	0.080	0.320	0.083	0.310	0.087	0.295
Percent of people are Hispanic in the HRR	0.183	0.061	0.164	0.096	0.182	0.068
Socioeconomic status						
Median household income ($1,000) in the HRR	-0.239	0.060	-0.229	0.075	-0.203	0.115
Percent of college graduate and above in the HRR	0.011	0.980	0.035	0.938	-0.017	0.971
Percent of people are management, professional, or related occupations in the HRR	0.755	0.019***	0.693	0.032***	0.703	0.032***
Health insurance						
Percent of people have any private health insurance in the HRR	0.832	0.191	0.718	0.266	0.812	0.212
Percent of people have any public health insurance in the HRR	0.517	0.423	0.349	0.595	0.451	0.495
Percent of people uninsured	0.723	0.349	0.613	0.433	0.710	0.367

in the HRR						
Urbanicity						
Percent of people live in urban area in the HRR	-0.041	0.489	-0.035	0.561	-0.027	0.658
Hospital characteristic						
Number of academic per 100,000 residents in the HRR	3.469	0.027***	3.436	0.031***	3.305	0.038***

***p<0.05

Discussion

Summary of Findings

Our study confirmed the hypothesis that as the supply of radiation oncologists in HRRs increased, inpatient mastectomy rate for early-stage breast cancer in HRRs would decrease. However, contradictory to our hypothesis, we also found that HRR-level supply of plastic and reconstructive surgeons is not associated with inpatient mastectomy rate for early-stage breast cancer in HRRs. Further, the supply of radiation oncologists, and plastic and reconstructive surgeons remains at similar supply structures across regions since 1996. These findings suggest that the supply of radiation oncologists might be the major constraint for BCT use and thus promoting the continued use of mastectomy for early-stage breast cancer at inpatient settings. It can also help explain the persistent of the geographic variation in early-stage breast cancer inpatient surgical care over time.

Policy Implications

The technology advance of BCT is widely accepted, and so we anticipated a rapid decrease in mastectomy use for early-stage breast cancer [6, 49, 50]. Nevertheless, as confirmed by our results and prior studies, many patients still undergo mastectomy and the surgery use

patterns across different regions have not changed significantly [6, 51, 52]. Understanding the reason behind continued mastectomy use will help seek solutions to this issue and achieve a standardized higher quality of breast cancer surgical care.

Prior studies that have tried to explain the persistent use of mastectomy have suggested continued use might due to the similarity of survival rate and quality of life between women receiving mastectomy with reconstruction and women receiving BCT, coupled with the fact that federal law requires that most insurance plans cover reconstruction after mastectomy under the WHCRA [52, 53]. The WHCRA mandate stimulated the growth of reconstructive surgeon workforce and also increased the affordability of reconstruction [52]. Thus, patients in regions with a higher reconstructive surgeon supply are more likely to perform mastectomy with reconstruction [52]. These justifications suggest that most of the women undergoing mastectomy would have adjunct reconstruction therapy, which may increase their quality of life [52].

However, this prior justifications are contradict to our study results, which shown that plastic and reconstructive surgeon supply is not significantly associated with inpatient mastectomy rate at HRRs for early-stage breast cancer. Further, our study shown that the supply of radiation oncologists did significantly decrease inpatient mastectomy rates for early-stage breast cancer. This may be because mastectomy is, in fact, a better option for patients who live in areas with a limited supply of radiation oncologists, given that BCT without adjuvant radiation therapy has been shown to lead to a higher recurrence rate and a lower survival rate, compared to mastectomy [51]. Differences in radiation oncologist supply across regions may, therefore, appropriately lead to the geographic variation on early-stage breast cancer inpatient surgical care.

To minimize the regional variation patterns on early-stage breast cancer, we propose several suggestions based on our study to help influence patients' treatment decisions, redirect

health resource distributions, and achieve a better and equal quality of care. First, given that current clinical guidelines note that BTC is the gold standard for treatment of early-stage breast cancer, appropriate monitoring systems set to standardized clinical practices should be implemented to ensure compliance with this guideline [9]. This could involve physicians reporting on their non-compliant activities, and compare physician performance and patients' outcomes across different regions regularly. Second, our results suggest that an inadequate supply and uneven distribution of radiation oncology workforce exists across different regions, so there might be a need to incentivize radiation oncologists to set up practice in low supply areas. Third, there are not many studies examined the geographic patterns of breast cancer surgical use at the national level. Greater attention should be paid to this issue by conducting studies to investigate the impact of regional supply disparity on the geographic variations of surgical care.

Limitations

This study has several limitations. First, we used cross-sectional data for this study, thus causality cannot be established. However, our study is the first study that examined the association between supply-side factors and national geographic variation of early-stage breast cancer surgical use at HRR-level. Further, longitudinal data is not readily available for breast cancer treatment, as most of the patients only go through BCT or mastectomy one time in their life. Previous study has also showed that although there was a modest growth in radiation oncology workforce between 1995 and 2007, the growth in different regions was stable[7]. Therefore, despite its cross-sectional design, our study made the best use of available data.

Second, our limited sample size (n=192) might pose an issue with the statistical power of this study. We used HRRs as the unit of analysis in this study. Further, 13 states in the NIS dataset did not include AHA hospital identifiers, so these states were excluded from the analysis because they cannot be used to create HRR-level data. However, the 13 states we excluded only represent 86 HRRs and we were still able to include 72% of the HRRs for this study. We also do not have enough early-stage breast cancer procedure cases to pursue a smaller regional level, due to data constraints.

Third, we did not measure individual-level factors in this study. We used contextual-level factors as their proxies, as shown in the conceptual framework (Figure 1). But there are still some factors that were unmeasured at both individual and contextual-level, which might pose the residual confounding threat on our study. Three important unmeasured factors were patients' health statues, patients' preferences and physician-patient communications. There are some cases where mastectomy might be an appropriate choice for those with high comorbidities and family history. Without differentiating appropriate and inappropriate use of mastectomy, this would potentially lead to construct validity threat for our study results. Further, there have been some debates about whether patients' preferences and physician-patient communications could impact regional difference in breast cancer treatments. According to the WHCRA, for early-stage breast cancer, treatment decision should be preference-based, and physicians are required to talk with their patients about the treatment options [52]. However, there is disagreement of the influence of patient preference in the literature. Some argue that institutional supply disparities might impact the contents of patient-physician communications, and thus changing patients' preferences and geographic surgery patterns [52]. While other studies show that patients are not actively involved in surgery decision-making process [47, 54, 55]. Therefore, the true impact of

leaving this unmeasured may be small. In addition, it is hard to quantify patient's involvement and patient-physician communications.

Fourth, we did not include outpatient data for this study. Today, most BCT procedures are performed in outpatient settings for early-stage breast cancer. Yet, national zip-code level outpatient breast cancer procedure information is unavailable. Mastectomy has mainly been done at inpatient settings and we used inpatient mastectomy rate as a proxy to examine the inappropriate surgical use. This could help reduce the construct validity threat caused by the data limitation.

Lastly, we used the years of 2008-2012 5-year estimates ACS data for the measure of HRR-level health insurance status, while all the other HRR-level demographics were measured at the year 2000. This might introduce statistical conclusion validity threat for our study, as HRR-level insurance status could be different between 2000 and the 2008-2012 5-year estimates. Health insurance is an important factor that impacts both patients' surgical decisions and health care infrastructures at different areas, and thus we should capture health insurance in our study. The data we used is the earliest year national zip-code level health insurance status that public available.

Future Research

In order to examine the association between regional supply factors on the geographic variation of early-stage breast cancer inpatient and outpatient surgical use, future research should focus on obtaining zip-code level national outpatient procedure information. Data showed that in 2012, 10.4 million inpatient services and 190 million outpatient services have been provided to Medicare beneficiaries in the U.S. and that outpatient use continues to grow [56]. This suggests

that outpatient services have become the major source of healthcare utilizations and spending in the U.S. Therefore, we should collect and publicize more outpatient data. Furthermore, with more inpatient and outpatient data, we could also examine breast cancer geographic patterns at a smaller area level, such as hospital services area, and census tract, which would reduce the aggregation bias of using HRR-level analysis in our study.

Despite these limitations, this study provides an important step in linking nationwide geographic variation of early-stage breast cancer surgical use with regional supply factors and informing the underlying causes of this geographic variation.

Conclusion

Previous studies have been conducted to explore the causes of regional variation of early-stage breast cancer surgical care from patient and hospital perspectives, this study contributes to existing literatures on examining this issue from market supply aspect. We found that while the supply of plastic and reconstructive surgeons in HRRs is not associated with HRR-level inpatient mastectomy rate for early-stage breast cancer, as the supply of radiation oncologists in HRRs increases, inpatient mastectomy rate in HRRs for early-stage breast cancer would decrease. These findings suggest that the supply disparity on radiation oncologists across regions may lead to the geographic variation on early-stage breast cancer inpatient surgical use. Therefore, aside from focusing on patient and provider, it is crucial to consider how market supply within different geographic locations may impact the surgical care patient receives, which could further affect patients' health outcomes and quality of life. However, due to the data constraint, this study has several major limitations. Future research should include early-stage breast cancer outpatient procedure data to draw a more accurate conclusion.

References

1. Birkmeyer, J.D., et al., Understanding of regional variation in the use of surgery. Lancet, 2013. **382**(9898): p. 1121-9.
2. Weinstein, J.N., et al., Trends and geographic variations in major surgery for degenerative diseases of the hip, knee, and spine. Health Aff (Millwood), 2004. **Suppl Variation**: p. VAR81-9.
3. Wennberg, J.E. and A. Gittelsohn, Health care delivery in Maine I: patterns of use of common surgical procedures. J Maine Med Assoc, 1975. **66**(5): p. 123-30, 149.
4. Wennberg, J.E., A. Gittelsohn, and N. Shapiro, Health care delivery in Maine, III: evaluating the level of hospital performance. J Maine Med Assoc, 1975. **66**(11): p. 298-306.
5. Practice, T.D.I.f.H.P.a.C. The Dartmouth Atlas of Health Care. 2014 [cited 2014 10/10]; Available from: http://www.dartmouthatlas.org/data/region/.
6. Fisher, S., et al., Treatment variation in patients diagnosed with early stage breast cancer in Alberta from 2002 to 2010: a population-based study. BMC Health Serv Res, 2015. **15**(1): p. 35.
7. Aneja, S., et al., Geographic analysis of the radiation oncology workforce. Int J Radiat Oncol Biol Phys, 2012. **82**(5): p. 1723-9.
8. Goodney, P.P., et al., Variation in the care of surgical conditions: Cerebral aneurysms, A.D.A.o.H.C. Series, Editor. 2014, Dartmouth Atlas of Health Care. p. 54.
9. NIH consensus conference. Treatment of early-stage breast cancer. Jama, 1991. **265**(3): p. 391-5.
10. Nattinger, A.B., et al., Minimal increase in use of breast-conserving surgery from 1986 to 1990. Med Care, 1996. **34**(5): p. 479-89.
11. Surveillance, E., and End Results Program, National Cancer Institute. Treatment distribution for invasive female breast cancer patients aged 20 years and older with AJCC stage less than IIA: 1992-2008. 2014 [cited 2014 10/10]; Available from: http://www.facs.org/cancer/ncdb.
12. Lu, M., et al., A systematic review of interventions to increase breast and cervical cancer screening uptake among Asian women. BMC Public Health, 2012. **12**: p. 413.
13. Group, U.S.C.S.W. United States Cancer Statistics: 1999–2010 Incidence and Mortality Web-based Report. Atlanta (GA): Department of Health and Human Services, Centers for Disease Control and Prevention, and National Cancer Institute. 2013 [cited 2014 10/10]; Available from: http://www.cdc.gov/uscs.
14. Dolan, J.T. and T.S. Granchi, Low rate of breast conservation surgery in large urban hospital serving the medically indigent. Am J Surg, 1998. **176**(6): p. 520-4.
15. Surveillance, E., and End Results Program. SEER Stat Fact Sheets: Breast Cancer. 2014 [cited 2014 10/10]; Available from: http://seer.cancer.gov/statfacts/html/breast.html.
16. Foundation, N.B.C. Breast cancer stages. 2014 [cited 2014 10/10]; Available from: http://www.nationalbreastcancer.org/breast-cancer-stages.
17. Hoover, S., E. Bloom, and S. Patel, Review of breast conservation therapy: then and now. ISRN Oncol, 2011. **2011**: p. 617593.
18. Lewis, D. and W.F. Rienhoff, Results of Operations at the Johns Hopkins Hospital for Cancer of the Breast: Performed at the Johns Hopkins Hospital from 1889 to 1931. Ann Surg, 1932. **95**(3): p. 336-400.

19. Halsted, W.S., I. The Results of Radical Operations for the Cure of Carcinoma of the Breast. Ann Surg, 1907. **46**(1): p. 1-19.
20. Engel, J., et al., Quality of life following breast-conserving therapy or mastectomy: results of a 5-year prospective study. Breast J, 2004. **10**(3): p. 223-31.
21. Jatoi, I. and M.A. Proschan, Randomized trials of breast-conserving therapy versus mastectomy for primary breast cancer: a pooled analysis of updated results. Am J Clin Oncol, 2005. **28**(3): p. 289-94.
22. Noel, G. and J.J. Mazeron, Long-term results of a randomized trial comparing breast-conserving therapy with mastectomy: European Organization for Research and Treatment of Cancer 10801 trial. Cancer Radiother, 2001. **5**(2): p. 211-2.
23. Dragun, A.E., et al., Increasing mastectomy rates among all age groups for early stage breast cancer: a 10-year study of surgical choice. Breast J, 2012. **18**(4): p. 318-25.
24. Farrow, D.C., W.C. Hunt, and J.M. Samet, Geographic variation in the treatment of localized breast cancer. N Engl J Med, 1992. **326**(17): p. 1097-101.
25. Nattinger, A.B., et al., Geographic variation in the use of breast-conserving treatment for breast cancer. N Engl J Med, 1992. **326**(17): p. 1102-7.
26. academies, I.o.M.o.t.n. Geographic Variation in Health Care Spending and Promotion of High-Value Care - Interim Report. 2014 [cited 2014 10/10]; Available from: www.iom.edu/
27. Osteen, R.T., et al., Regional differences in surgical management of breast cancer. CA Cancer J Clin, 1992. **42**(1): p. 39-43.
28. Gomez, S.L., et al., Increasing mastectomy rates for early-stage breast cancer? Population-based trends from California. J Clin Oncol, 2010. **28**(10): p. e155-7; author reply e158.
29. Kotwall, C.A., et al., Patient, hospital, and surgeon factors associated with breast conservation surgery. A statewide analysis in North Carolina. Ann Surg, 1996. **224**(4): p. 419-26; discussion 426-9.
30. Newman, L.A. and H.M. Kuerer, Advances in breast conservation therapy. J Clin Oncol, 2005. **23**(8): p. 1685-97.
31. White, A., et al., Socioeconomic disparities in breast cancer treatment among older women. J Womens Health (Larchmt), 2014. **23**(4): p. 335-41.
32. Robert, S.A., et al., Socioeconomic risk factors for breast cancer: distinguishing individual- and community-level effects. Epidemiology, 2004. **15**(4): p. 442-50.
33. Foster, R.S., Jr., M.E. Farwell, and M.C. Costanza, Breast-conserving surgery for breast cancer: patterns of care in a geographic region and estimation of potential applicability. Ann Surg Oncol, 1995. **2**(3): p. 275-80.
34. Johantgen, M.E., et al., Treating early-stage breast cancer: hospital characteristics associated with breast-conserving surgery. Am J Public Health, 1995. **85**(10): p. 1432-4.
35. Satariano, E.R., G.M. Swanson, and P.P. Moll, Nonclinical factors associated with surgery received for treatment of early-stage breast cancer. Am J Public Health, 1992. **82**(2): p. 195-8.
36. Voogd, A.C., et al., Differences in risk factors for local and distant recurrence after breast-conserving therapy or mastectomy for stage I and II breast cancer: pooled results of two large European randomized trials. J Clin Oncol, 2001. **19**(6): p. 1688-97.
37. Barlow, W.E., et al., Cost comparison of mastectomy versus breast-conserving therapy for early-stage breast cancer. J Natl Cancer Inst, 2001. **93**(6): p. 447-55.

38. Desch, C.E., et al., A sociodemographic and economic comparison of breast reconstruction, mastectomy, and conservative surgery. Surgery, 1999. **125**(4): p. 441-7.
39. State laws relating to breast cancer. 2010 [cited 2015 03/03]; Available from: http://www.cdc.gov/cancer/breast/pdf/BClaws.pdf.
40. American Society of Plastic Surgeons: State laws on breast reconstruction. 2015 [cited 2015 03/03]; Available from: http://www.plasticsurgery.org/reconstructive-procedures/breast-reconstruction/breast-reconstruction-resources/state-laws-on-breast-reconstruction.html.
41. Greenberg, C.C., et al., Institutional variation in the surgical treatment of breast cancer: a study of the NCCN. Ann Surg, 2011. **254**(2): p. 339-45.
42. Hahn, C.A., et al., Breast conservation rates-barriers between tertiary care and community practice. Int J Radiat Oncol Biol Phys, 2003. **55**(5): p. 1196-9.
43. Andersen, R.M. and P.L. Davidso, Improving access to care in America: Individual and Contextual Indicators. 2001.
44. United States Census Bureau: The 2008-2012 ACS 5-Year Summary File Technical Documentation. 2014 [cited 2015 02/24]; Available from: http://www2.census.gov/acs2012_5yr/summaryfile/ACS_2008-2012_SF_Tech_Doc.pdf.
45. Mave, V., et al., Impact of maternal hepatitis B virus coinfection on mother-to-child transmission of HIV. HIV Med, 2014. **15**(6): p. 347-54.
46. United States Census Bureau: Census 2000 data for the United States. 2010 [cited 2015 03/03]; Available from: http://www.census.gov/census2000/states/us.html.
47. United States Census Bureau: American community survey summary file. 2015 [cited 2015 03/03]; Available from: http://www.census.gov/acs/www/data_documentation/summary_file/.
48. Kahn, L.H., et al., The validity of hospital administrative data in monitoring variations in breast cancer surgery. Am J Public Health, 1996. **86**(2): p. 243-5.
49. Morris, A.D., et al., Breast-conserving therapy vs mastectomy in early-stage breast cancer: a meta-analysis of 10-year survival. Cancer J Sci Am, 1997. **3**(1): p. 6-12.
50. van de Water, W., et al., Breast-conserving surgery with or without radiotherapy in older breast patients with early stage breast cancer: a systematic review and meta-analysis. Ann Surg Oncol, 2014. **21**(3): p. 786-94.
51. Onitilo, A.A., et al., Survival Comparisons for Breast Conserving Surgery and Mastectomy Revisited: Community Experience and the Role of Radiation Therapy. Clin Med Res, 2014.
52. Kummerow, K.L., et al., Nationwide trends in mastectomy for early-stage breast cancer. JAMA Surg, 2015. **150**(1): p. 9-16.
53. Dehal, A., A. Abbas, and S. Johna, Racial disparities in clinical presentation, surgical treatment and in-hospital outcomes of women with breast cancer: analysis of nationwide inpatient sample database. Breast Cancer Res Treat, 2013. **139**(2): p. 561-9.
54. O'Brien, M.A., et al., Physician-related facilitators and barriers to patient involvement in treatment decision making in early stage breast cancer: perspectives of physicians and patients. Health Expect, 2013. **16**(4): p. 373-84.
55. Lee, C.N., et al., Decision making about surgery for early-stage breast cancer. J Am Coll Surg, 2012. **214**(1): p. 1-10.

56. Services, C.f.M.a.M. Are You a Hospital Inpatient or Outpatient? If you have Medicare - Ask! 2015 2015/02/15; 8]. Available from: https://www.medicare.gov/Pubs/pdf/11435.pdf.