Does market competition reduce hospital charges and length of stay for the degenerative lumbar spinal disease?

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A Masters Thesis

Submitted to the Department of Hospital Administration
and the Graduate School of Public health
Yonsei University

In partial fulfillment of the
Requirements for the degree of
Master of Public Health

Joo Eun Lee

December 2014

This certifies that the Masters Thesis of Joo Eun Lee is approved.

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December 2014

Acknowledgements

During my master course, there are many people who supported me. I noticed that God has a wonderful plan for my life and always arranged everything. I give thanks to God and glorify Him.

My sincere thanks go to members of my master's thesis committee, Prof. Tae Hyun Kim, Prof. Eun-Cheol Park and, Prof. Sang Gyu Lee. I would like to express my greatest gratitude to my advisor and chair of my master's thesis committee, Prof. Tae Hyun Kim for his support, encouragements, and his constructive feedbacks. He gave me his time to discuss the direction of the thesis, and guided me to find the way to go. Also, I sincerely thank Prof. Eun-Cheol Park for his comments and his profound insights. He challenged me, and advised for the writing of the thesis. I also specially appreciate Prof. Sang Gyu Lee's kindness. I have learned a lot from his class and helpful discussions.

To professors and colleagues in preventive medicine department of Yonsei Wonju college of medicine, I thank you all for your kindest support.

Finally, I would like to thank my family and friends, especially my loving husband, my parents, and my parents-in-law who supported and encouraged me.

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Abstract

Does market competition reduce hospital charges and length of stay for the degenerative lumbar spinal disease?

Medical care utilization and expenditure for patients with degenerative lumbar spinal (DLS) disease in Korea have continuously increased. In addition, the charges for lumbar spine surgery admission have a wide variance depending on the type of hospital and average length of stay (LOS). Concurrently, higher competition caused by the growth of general and specialized hospitals may have influenced recent trends in DLS treatments. However, there is limited empirical evidence on whether market competition leads to an overall improvement in efficiency.

This study examines whether hospital market competition is associated with charges and LOS for patients with DLS disease. The conceptual framework of this study is derived from the field of industrial organization, in which market structure (i.e., the number of hospitals, distribution, and market-entry barriers) is assumed to affect the behaviors of hospital service providers and eventually disease outcomes.

This study used nationwide cohort sample data of health insurance claims and patient discharge data by the Ministry of Health and Welfare (MOHW) and the Korea Institute for Health and Social Affairs (KIHASA) for DLS disease in 2002 and 2010. In total, 24,768 subjects (4,891 in 2002 and 19,877 in 2010) were analyzed. To measure the market competition level, the Hirschmann–Herfindahl Index (HHI) was used. After adjusting for confounders in the Structure–Conduct–Performance (S–C–P) model, we created a mixed linear model using hospital competition as the principle independent variable and charges and LOS as the dependent variables.

The total average charge was 306,351 won in 2002 and 250,723 won in 2010. Furthermore, the average LOS was 2.98 days in 2002 and 2.79 days in 2010. In addition, we found that the HHI was associated with hospital charges and LOS for DLS disease. The HHI showed a significant association with higher total charges (in 1,000 won) among inpatients with DLS disease in 2002 and 2010. The HHI was also associated with longer LOS for DLS disease. Compared to low competition level (high HHI), high competition level (low HHI) was associated with both lower charges and shorter LOS. In addition, the results of the subgroup analysis for patients without comorbidity and those of analysis for all patients pointed in the same direction. For hospitals with 300 beds or less, higher competition is associated with increases in charges and LOS in both 2002 and 2010. By contrast, in hospitals with more than 300 beds, higher market competition reduced charges over time.

This empirical study showed that hospital market structure (e.g., hospital competition) affects hospital efficiency (i.e., hospital charges and LOS). Therefore, the government must keep an eye on the changing hospital market structure that influences hospital outcomes. Future studies should investigate more detailed effects of competition on DLS disease outcomes, such as patient satisfaction.

Keywords: hospital competition, Hirschmann–Herfindahl Index, hospital charges, length of stay

1. Introduction

In recent years, the socioeconomic cost of surgery for disease of lumbar spine has increased dramatically (Bederman, 2009). Medical care utilization and expenditure for spinal surgery in South Korea (Korea henceforth) have more than doubled in the period 2002–2007. While the average annual rate of increase in spinal surgeries in the United States was 4.54% over the past 11 years, the rate in Korea was 25.36% during the past 3 years (Health Insurance Review & Assessment Service (HIRA), 2009). Moreover, the lumbar region accounts for most spinal surgeries according to health insurance claims (HIRA, 2007).

Medical care utilization and expenditure for patients with DLS disease in Korea have continuously increased. In addition, the charges for lumbar spinal surgery admission vary widely depending on the type of hospital and the average length of stay (LOS), which is much lengthier in Korea than in other countries (HIRA, 2014). However, higher competition between hospitals owing to the increased number of general and specialized hospitals may have influenced recent DLS treatment trends. As a result, hospital efficiency fluctuates. An OECD committee discussed the role of hospital competition in healthcare expenditures in 2012 (OECD Competition Law & Policy, 2012). Total expenditure on healthcare amounts to 7.6% of GDP in Korea, which is lower than the OECD average of 9.3%. However, in recent years, high-spending OECD countries have lowered the rate of increase in healthcare spending by developing efficient healthcare policies. On the other hand, in Korea, the annual growth rate of total expenditures on healthcare is still high (OECD, 2014). Thus, using competition as a mechanism for costs, quantity and quality controls should be considered to resolve these increases in healthcare spending (Maier-Rigaud, 2012).

It is necessary to investigate long-term changes in competition to analyze the competitive behavior of hospitals (Feldstein, 2004). However, most studies on the subject have utilized short-term data. Therefore, in this paper, we used cohort data from 2002 and 2010 in Korea to determine changes in market competition and their effects. The aim of this study is to verify how hospital market competition is associated with hospital charges and LOS.

2. Literature review

2.1. Hospital competition

Competition in the healthcare market has intensified over the last few decades (Vogt & Town, 2006; Kim et al., 2014). In economics, competition refers to the rivalry between parties such as individuals or groups that arises whenever at least two of the parties strive for something that cannot be shared (Stigler, 1987). On the other hand, hospital competition differs from other industries based on price competition and the principle of profit maximization (Noether, 1988). In general, competition leads to better performance in terms of improvements in quality and reductions in price. In contrast, in the medical industry, competition is often related to privatization. This has been a critical issue in Korea lately, and it can cause price fluctuations and deterioration of health outcomes (OECD, 2012).

Many studies have been conducted on market competition and hospital efficiency. Studies using data from prior to the mid-1980s in USA mostly proposed that competition may result in inefficiencies in healthcare systems (Joscow, 1980; Robinson & Luft, 1985, 1987; Farley, 1985; Luft et al., 1986; Noether, 1988). Especially because of healthcare insurance and payment systems, consumers were sensitive to quality rather than price, causing a “medical arms race” and the provision of unnecessarily expensive medical services (Held & Pauly, 1983; Kessler DP, 1999). Competition in the supply of high-tech services implied an association between hospital competition and costs (Propper, 1996). Some studies have found that treatment costs were higher in more competitive areas (Robinson & Luft, 1987; Koch, 1993; Kim et al., 2014). However, since the introduction of diagnosis-related groups (DRGs) and managed care in the United States and the shift from non-price competition to price competition, it has been found that high competition may reduce the increasing rates of medical expenses (Melnick & Zwanziger, 1988; Melnick et al., 1992; Propper, 1996; Park, 2006). In this situation, growing competition may place strong pressure on cost reductions and improved efficiency of hospital care (Mayo & McFarland, 1989; Rivers & Fottler, 2004). However, some studies have found that cost competition is associated with deteriorating health outcomes (Kassirer, 1995; Mukamel, Zwanziger, & Bamezai, 2002; Volpp et al., 2003; Propper, Burgess, & Green, 2004), whereas other studies have doubted whether hospital competition is related to either treatment cost or quality of hospital care (Fournier, 1992; Reinhardt, 1996; Propper, 1997; Propper & Söderlund, 1998; Hirth, Chernew, & Orzol, 2000; Mukamel, Zwanziger, & Tomaszewski, 2001).

Concerning the debate about healthcare competition and its effects, more studies on the subject are required (Chang, 2011). In Korea, the government has introduced and stimulated competition between hospitals. In this study, we attempt to find the effects of hospital competition on efficiency.

2.2. Healthcare market in Korea

Unlike the United States, there is a National Health Insurance System (NHIS) in Korea providing universal health coverage with an average 20% copayment. In addition, there is a fee-for-service (FFS) hospital payment system in Korea (excluding the DRGs, which cover seven disease groups). The FFS, which depends on the quantity of treatments, affects the behavior of healthcare providers. Moreover, when patients pay for part of the cost of universal health coverage, doctors may supply more treatment than required. Most hospitals are private, and hospitalization charges are standardized by the Ministry of Health and Welfare (MOHW), which determines the health service areas and the number of hospitals in each area. Overall, 16 administrative districts are mixed and grouped into 10 healthcare service areas. In addition, the number of doctors, number of beds, and other resources are controlled by the government.

Depending on the market structure, the effects of competition on hospital performance may differ. Thus, the effects in the United States differ from those in Korea.

Most hospital competition studies conducted in Korea have focused on factors at the patient and hospital level as confounding variables or have used short-term data. Park (2006) used data from 2002 to 2003 and adjusted only hospital-level factors as confounding variables, while Park (2008) adjusted the socioeconomic characteristics of the market and market structure but used data covering only 1 month of health insurance claims in January 2002. Kim (2012) used outpatient health insurance claims in 2010 and adjusted the socioeconomic characteristics of the market (i.e., education level, population density, the ratio of persons 65 years of age or older, and per-capita GDP) as market-level confounding variables. Kim et al. (2014) used data from November 1^{st}, 2011 to May 31^{st}, 2012 on adjusted per-capita GRDP as the market-level confounding variable. While these studies used short-term data or a partially adjusted market-level confounding factor, the current study used cohort data from health insurance claims in 2002 and 2010 as the main data as well as adjusted socioeconomic characteristics of the market (i.e., population density, taxes, and education level) and hospital market structure (i.e., number of beds and doctors).

2.3. Defining the hospital market

2.3.1. Cross-elasticity of demand

Cross-elasticity of demand is measured as the % change of demand for a product to the % change in price of another product. In economics, firms are in the same market if they affect mutual pricing and production decisions (Palamgkaraya & Yong, 2009). Some studies have proposed that cross-elasticity of demand can contribute to defining markets in terms of price or non-price variables of interest (Luft et al., 1989). However, this approach is not feasible for hospital markets, because hospital price data is usually unavailable (Gaynor & Vogt, 2003).

2.3.2. The Elzinga–Hogarty (E–H) method

A well-known approach that uses product flow information is that proposed by Elzinga and Hogarty (1973). They suggested to set markets as geographic areas if the consumption produced outside is not more than 10% (i.e., little in from outside (LIFO)) and if production consumed outside is not more than 10% (i.e., little out from inside (LOFI)). Insignificant patient flows indicate that hospitals in one area are not in competition with hospitals in other areas (Econex, 2006). The E–H approach is conceptually compelling, but some limitations exist in applying the approach (Gaynor & Vogt, 2000; Dranove & White, 1994; Zwanziger, Melnick, & Eyre, 1994), which requires the location of both patients and hospitals (Dranove, Shanley, & Simon, 1992), and there is a practical problem of market overlap. If markets overlap, the decision on the extent of overlap is arbitrary (Dranove, Shanley, & White, 1993).

2.3.3. Geopolitical boundaries

Geopolitical boundaries using geopolitical units are the most easily employed (Romeo et al., 1984; Lynk, 1995; Gaynor & Vogt, 2000; Schneider, 2008; USA Department of Commerce, 2012). This approach is attractive because it is simple to calculate and does not require patient flow information. The other advantage of using geopolitical boundaries to define market areas is the availability of socioeconomic data (Garnick et al., 1987). On the other hand, a disadvantage of using geopolitical boundaries is that hospital market areas may be arbitrarily defined (Vistness, 1995; Kleiner, 2012). If market areas are grouped by administrative district with a high degree of socioeconomic cohesion, the competition level can be overestimated or underestimated (Zwanziger, Melnick, & Eyre, 1994). In addition, the approach cannot be applied to structure–conduct–performance (S–C–P) studies (Park, 2006). Nevertheless, many previous studies in Korea used the approach to define hospital market areas (Sagong & Kown, 2011; Kim, 2012; Kim et al., 2014).

2.3.4. Fixed radius

The fixed-radius approach is an alternative to geopolitical boundaries. This approach, proposed by Luft and Maerki (1984), uses a fixed radius around each hospital. The study by Jo, Lim, and Lee (2008) implemented the approach for Korea. Because the fixed radius is settled with a circle centered on each hospital, the advantage of the fixed-radius method is that it can include competitors located outside geopolitical boundaries. Luft and Maerki (1984) recommended fixing the radius to no more than 15 miles. However, fixing the radius is a weakness of the approach, because the size of markets differs depending on the hospital type (Zwangziger, Melnick, & Mann, 1990).

2.3.5. Variable radius

Phibbs & Robinson (1993) proposed the variable-radius approach as an alternative method to the fixed-radius approach, and Gresenz et al. (2004) updated it. Under the approach, hospital market areas vary in size, while a market is defined as a radius around each hospital, like the fixed-radius approach. However, compensating for the defects of the fixed-radius approach, the variable-radius approach allows the radius to vary so that it captures 75% or 90% of the patients. A unique hospital market area is defined for every hospital using this approach (Wong et al., 2005).

2.3.6. Patient flow

The patient flow approach uses patient origination data and defines market areas as a collection of ZIP codes that send a certain percentage of patients (e.g., 40–95% of hospital discharge patients) to hospitals in the area (Garnick et al., 1987; Zwanziger & Melnick, 1988). The approach disregards areas that house a low percentage of hospital discharge patients (i.e., 1–3% or less; Zwangziger, Melnick, & Mann, 1990; Korea Institute for Health and Social Affairs, 2013). The advantage of this approach is that it can assess the relationship among the structure, conduct, and performance of hospitals by calculating the competition level of each hospital (Park, 2006).

2.4. Measuring hospital competition level

2.4.1. Number of hospitals

After defining the hospital market area, a measure for hospital competition must be decided. The number of hospitals is a method used frequently for studies defining market areas as a certain radius centered on the hospital. The advantage of the method is computational ease. On the other hand, it does not consider differences in the size of hospitals and market share (Baker, 2001).

2.4.2. The Herfindahl–Hirschman Index

The Herfindahl-Hirschman Index (HHI) is used to reflect the differences in hospital market share and has been used as an indicator of competition level among hospitals as an alternative to the number of hospitals. The HHI sums the squared market shares of each hospital in a market (Feldstein, 2004), and the market shares are usually calculated from the number of discharges (Zwangziger, Melnick, & Mann, 1990). The HHI is the preferred method in the healthcare industry, because it reflects both the number of competitors and the distribution of market shares. However, there exists a practical problem in that it is difficult to obtain available data to accurately calculate the HHI (Noh et al., 2007). Patient and hospital market data must be connected, and hospital data must include all hospitals in the market area (Palankaraya & Yong, 2009). Nevertheless, the HHI is the standard method for measuring market competition.

2.4.3. Concentration ratio

Another method of measuring hospital competition intensity in a market is a concentration ratio. Common concentration ratios that measure dispersion of market shares are typically CR4 and CR8, indicating dispersion of market shares of the largest four or eight hospitals, respectively. Thus, this method has limited information (Wong et al., 2005; Park, 2006).

2.5. Theoretical foundation

In the field of industrial organization, market structure affects the behaviors of providers and eventually the outcomes (Lee, 2001). The S–C–P paradigm of industrial organization can be also applied to the healthcare industry. Thus, the conceptual framework of this study is derived from the field of industrial organization, in which the market structure (i.e., the number and distribution of hospitals, which are barriers to market entry) is assumed to affect the behaviors of hospital service providers and eventually the outcomes (Figure 1).

Many studies that examine the impact of hospital market competition on patient outcomes have used the S–C–P theory as a mechanism (Gaynor & Vogt, 2003; Rivers & Fottler, 2004; Vogt & Town, 2006; Hearld et al., 2008; Park, Kwon & Jung, 2008). Furthermore, previous studies have indicated that outcomes depend on characteristics of multilevel factors (i.e., patients, hospitals, and socioeconomic environment characteristics; Rivers & Fottler, 2004; Burgess, 2005). Some studies have also suggested that the effect of competition differs depending on the market structure (Sari, 2002; Burns et al. 2005; Vogt & Town, 2006; Park, Kwon & Jung, 2008).

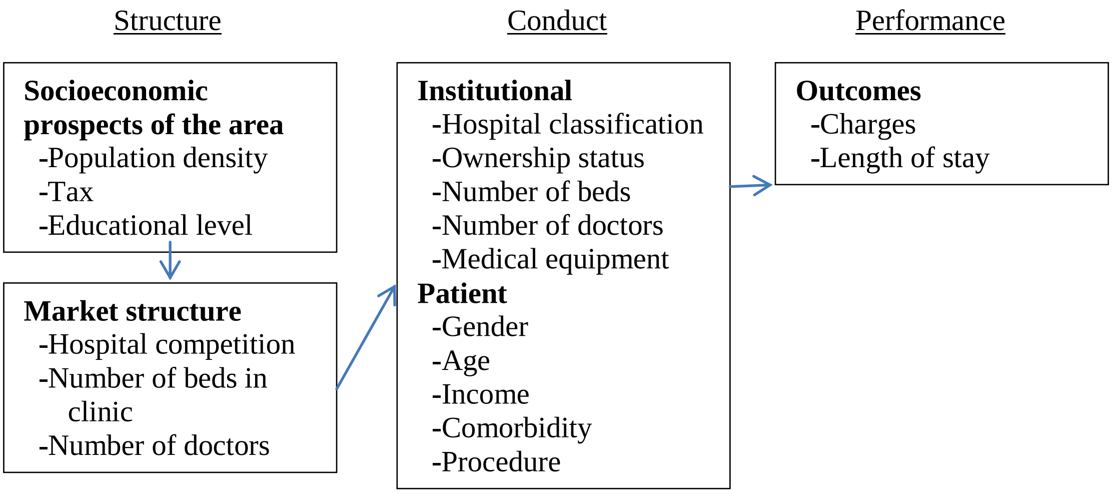

Fig. 1. Modified S–C–P model.

Using the modified S-C-P framework, this study divided structure into socioeconomic characteristics and hospital market structure (Scherer & Ross, 1990). Considering the possibility of endogenous variables, we first analyzed the association between socioeconomic characteristics and market competition. Then, we excluded socioeconomic characteristics and analyzed the associations between market competition and hospital charges and LOS. Conduct indicates the behavior of hospitals and includes hospital type, ownership type, number of beds, number of doctors, and technology, whereas performance indicates the effect of market structure on hospital efficiency. The S–C–P framework hypothesizes that structure affects the conduct of hospitals and ultimately performance (Gaynor, 2006).

3. Methods

3.1. Data source and study sample

We used nationwide cohort sample data of health insurance claims by the NHIS as our main data as well as patient discharge data by the MOHW and the KIHASA to calculate the HHI in 2002 and 2010. Variables for market structure were calculated using data from the Korea National Statistical Office (KOSTAT). Only patients who were hospitalized with DLS disease were included in this study. The sample consisted of 4,891 persons in 2002 and 19,877 persons in 2010. In total, there were 2,208 patients without comorbidity in 2002 and 6,400 in 2010. In addition, 995 patients in 2002 and 4,521 in 2010 were admitted to hospitals with 300 or less beds among those without comorbidity. Those admitted to hospitals with more than 300 beds numbered 1,267 in 2002 and 2,098 in 2010.

3.2. Case selection

The subjects of this study included only those with DLS disease. Thus, they were defined using primary diagnostic codes in medical statements. The following codes were analyzed: “other intervertebral disc disorders,” “spinal stenosis,” “specified spondylopathies,” “spondylopathies,” “spondylolysis,” “other fusion of spine,” and “deforming dorsopathies.”

Both operative and nonoperative treatments were included for patients with DLS disease. Therefore, the types of surgery included in this study were arthrodesis for spinal deformity, arthrodesis of spine, diskectomy, and laminectomy (Table 1).

Table 1. List of surgical procedures

List of surgical procedures			Medical procedure code
Arthrodesis for spinal deformity	Anterior technique		N0444 N0445
	Posterior technique		N0446 N0447
Arthrodesis of spine	Anterior technique	(Lumbar spine)	N0466
	Posterior technique	(Lumbar spine)	N0469
Diskectomy	Invasive	(Lumbar spine)	N1493
	By endoscopy		N1494
	Injection procedure for chemonucleolysis		N1495
	Aspiration procedure of nucleus pulposus of intervertebral disk		N1496
Laminectomy		(Lumbar spine)	N1499

3.3. Variables

3.3.1. Dependent variables

The dependent variables and their definition sources are shown in Table 2. Total charges and LOS were considered in measuring hospital performance in 2002 and in 2010. “Total charges” are the total payments for each year, and “Total LOS” indicates the total LOS for each year.

3.3.2. Independent variables

Table 2 shows the main independent variable and the control variables. Patient variables include gender, age, income, disease diagnosis, comorbidity, and procedure (surgery or nonoperative treatments). Institutional variables include hospital classification (teaching/general hospital or small hospital), ownership status (public or private), number of beds, number of doctors, and medical equipment (CT and/or MRI).

Regional-level variables include socioeconomic variables and hospital market ones. The main independent variable was the HHI for hospital markets. To calculate the HHI, we measured markets using the patient flow approach. The maximum cutoff value of the market area is 80% of a hospital's patients, and the marginal value is 1% of its patients (Zwangziger, Melnick, & Mann, 1990). Following the study by Korea Institute for Health and Social Affairs (2013), we calculated the HHI along with patient discharge data for the zip code of residence and institutional data for the hospital administrative district and the number of discharges. Then, we divided the hospital market depending on the health service area to analyze the HHI. In this study, regional-level variables were divided by health service area, and the MW determined 10 health service areas reflecting past hospital utilization patterns. Socioeconomic variable used include population density, tax, and education level. Hospital market variables include hospital competition level, number of beds in the clinic, and number of doctors.

Table 2. Variables, definitions, and sources

Variable	Definition	Source
<u>Outcome variables</u>		
Charges	Total charge (per 1,000won)	NHIS
Length of stay(LOS)	Total length of stay	NHIS
<u>Patient</u>		
Gender	Male, female	NHIS
Age	Less than 40, 40~64, 65 and more	NHIS
Income	Quintiles of Income divided by health insurance premium per family unit	NHIS
Comorbidity	Comorbidity status on medical statement	NHIS
Procedure	The number of surgery for degenerative lumbar spine	NHIS
<u>Institutional</u>		
Hospital classification	Teaching hospital or general hospital, Small hospital	NHIS
Ownership status	Public, Private	NHIS
Number of beds	30~300, 301~500, 501~1000, 1001~1500, 1500 and more	NHIS
Number of doctors	Number of doctors of each hospital	NHIS
Medical equipment	CT, MRI	NHIS
<u>Socioeconomic prospects of the area</u>		
Population density	People per square kilometer	KOSTAT
Tax	Local tax (per 1,000,000won)	KOSTAT
Education level	College graduation rate	KOSTAT
<u>Market structure</u>		
Hirschmann-Herfindahl Index(HHI)	Summing the squared market shares of each hospital in market (by 100 points)	KIHASA
Number of beds in clinic	Average number of beds in clinic (per 1000 persons)	KOSTAT
Number of doctors	Average number of doctors (per 1000 persons)	KOSTAT

3.4. Analytic approach

3.4.1. Statistical analysis

Descriptive statistics of health service area, hospital, and patient characteristics are presented as follows. First, this study conducted a linear mixed model using socioeconomic characteristics as independent variables and hospital competition level as the dependent variable. Because the market competition variable could be endogenous, we first analyzed the association of socioeconomic characteristics with market competition and then that of market competition with charges and LOS excluding socioeconomic characteristics. After adjusting for confounders in the S–C–P model, we conducted a linear mixed model using hospital competition as the principle independent variable and charges and LOS as the dependent variables. The advantage of repeated measurements is that it is the only type of measurement which is available for obtaining individual change patterns. The equation for the linear mixed model is as follows:

$$Y_i = X_i\beta + Z_i\gamma_i + \varepsilon_i, \qquad i = 1, \ldots, n,$$

Here, β_i is a regression coefficient and γ_i is a random effect for subject i. In this model, the subject can have a variety of observations, and observation times may differ among subjects (Davis, 2002). Because the distribution of the HHI and the number of doctors are skewed, a log transformation was applied to these variables. All individual patient-level, hospital-level, and health service-area-level data were included in our linear mixed model. SAS 9.4 was used for all analysis.

3.4.2. Subgroup analysis

In order to create homogeneous groups, patients with comorbidity were excluded from our subgroup analysis. After conducting the subgroup analysis, we divided patients without comorbidity by the number of beds: 300 beds or less and more than 300 beds. Thus, small and large hospitals are respectively classified by the number of beds. The classification standard for determining hospital size by the number of beds is generally 300.

4. Results

4.1. Patient, hospital, and market characteristics

Table 3 displays the descriptive statistics on the patient, hospital, and market characteristics. The average of total charges in 2002 was 306,351 won and the standard deviation was 1,060,712 won. The average of the total charges in 2010 was 250,723 won, while the standard deviation was 783,710 won. In addition, in 2002, the average LOS was 2.98 days and the standard deviation was 4.91 days, whereas the average LOS in 2010 was 2.79 days and the standard deviation was 4.37 days. Furthermore, the average of the outcome variables decreased in the period 2002–2010. Patients over 65 years old increased from 21.96% in 2002 to 30.41% in 2010. The number of patients by income has no significant change, but income is positively correlated with the patient ratio. In addition, the ratio of patients with comorbidity increased from 63.77 in 2002 to 77.72 in 2010. According to a report by the HIRA, the number of spinal surgery procedures per 100,000 persons was 327 cases in 2010. Compared with existing reference data, there were a similar number of DLS surgeries in this study (N = 218 in 2010).

Next, the characteristics for number of patients by hospital are shown in Table 3. Of the DLS disease patients, those admitted to teaching or general hospitals decreased from 63.78% to 37.40% in the period 2002–2010. However, those admitted to small hospitals increased from 36.13% in 2002 to 62.60% in 2010. The ratio of patients admitted to hospitals with more than 30 but fewer than 300 beds increased from 40.85 to 68.68 in 2002–2010, but the ratio of patients admitted to hospitals with over 500 beds decreased. In addition, the number of doctors in hospitals where patients were hospitalized decreased (mean = 157.43 in 2002; mean = 91.59 in 2010), and the number of patients in hospitals with CT scanners or MRI machines decreased over the period 2002–2010. These trends might be affected by the increase in the number of patients admitted to small hospitals.

Lastly, population density, taxes, and education level increased. The reduced HHI during the period indicates increased competition level. The distribution of the HHI was extremely skewed left. All 10 population service areas located in Korea experienced increased competition over 2002–2010, whereas the number of beds per clinic (per 1,000 persons) decreased and the number of doctors (per 1,000 persons) increased.

Table 3. Descriptive statistics in 2002 and 2010

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Patient-level				
Charges[a]		306,351 ±1,060,712		250,723 ±783,710
Length of stay		2.98 ±4.91		2.79 ±4.37
Gender				
Male	2,188 (44.74)		8,416 (42.34)	
Female	2,703 (55.26)		11,461 (57.66)	
Age				
Less than 40	1,259 (25.74)		3,811 (19.17)	
40~64	2,558 (52.30)		10,022 (50.42)	
65 and more	1,074 (21.96)		6,044 (30.41)	
Income				
Medical aid	12 (0.25)		48 (0.24)	
20% and less	602 (12.31)		2,745 (13.81)	
21~40%	741 (15.15)		2,820 (14.19)	
41~60%	864 (17.67)		3,606 (18.14)	
61~80%	1,156 (23.64)		4,498 (22.63)	
81% and more	1,516 (31.00)		6,160 (30.99)	

Table 3. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Comorbidity				
No	1,772 (36.23)		4,428 (22.28)	
Yes	3,119 (63.77)		15,449 (77.72)	
Procedure				
Nonsurgery	98,851 (99.92)		540,492 (99.96)	
Surgery	76 (0.08)		218 (0.04)	
Hospital-level				
The number of patients by hospital classification				
Teaching hospital or general hospital	3,124 (63.87)		7,434 (37.40)	
Small hospital	1,767 (36.13)		12,443 (62.60)	
The number of patients by ownership status				
Public	68 (1.39)		403 (2.03)	
Private	4,823 (98.61)		19,474 (97.97)	

Table 3. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
The number of patients by number of beds				
30~300	1,998 (40.85)		13,652 (68.68)	
301~500	366 (7.48)		1,723 (8.67)	
501~1000	1,592 (32.55)		3,081 (15.50)	
1001~1500	559 (11.43)		836 (4.21)	
1500 and more	376 (7.69)		585 (2.94)	
The number of doctors		157.43 ±208.04		91.59 ±221.84
The number of patients by existence of CT				
No	66 (1.35)		2,014 (10.13)	
Yes	4825 (98.65)		17,863 (89.87)	
The number of patients by existence of MRI				
No	539 (11.02)		2,807 (14.12)	
Yes	4,352 (88.98)		17,070 (85.88)	

Table 3. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Socioeconomic prospects of the area				
Population density		1,717.77 ±1,708.57		1,852.46 ±1,909
Tax(per 1,000,000won)		5,544,045 ±4796299		6,029,569 ±1222509
Education level		0.18 ±0.03		0.28 ±0.04
Market structure				
HHI(by 100 points)		3.33 ±2.89		2.36 ±1.73
The number of beds in clinic (per 1000 persons)		1.57 ±0.67		1.53 ±0.59
The number of doctors (per 1000 persons)		0.69 ±0.20		0.95 ±0.26
Number of patients	4,891 (100)		19,877 (100)	

[a]Unit: Korean Won.

Tables 4 and 5 shows the characteristics of socioeconomic prospects and hospital market structure by health service area. Of the markets for DLS disease, the capital area was the most competitive market with an HHI of 119.93, whereas the Kang-Won area was the least competitive market with an HHI of 1,298.36 in 2002. On the other hand, the capital area had the least number of beds and least number of doctors per 1,000 persons in the clinics. In terms of population density, west Gyeong-Gi was the highest and Kang-Won was the lowest. Tax per 1,000,000 won was highest in the capital area and lowest in the Chung-Buk area. In terms of education level, that in the capital area was the highest and that in the Kang-Won area was the lowest. The structural characteristics in 2010 showed a similar status to those in 2002 except for the HHI: the southern Gyeong-Gi area had an HHI of 87.20 and was more competitive than the capital area with an HHI of 108.32 in 2010.

Table 4. Characteristics of structure by population service area in 2002

population service areas	N	HHI	Number of beds in clinic per 1000 persons	Number of doctors per 1000 persons	Population density	Tax per 1,000,000won	Education level
Capital area	1392	119.93	0.77	0.49	2345	12,950,488	0.22
West Gyeong-Gi area	513	245.81	2.33	0.72	5537	3,812,566	0.18
South Gyeong-Gi area	430	125.53	2.12	1.01	3396	2,590,794	0.18
Kang-Won area	224	1298.36	2.25	0.65	91	709,719	0.13
Chung-Buk area	184	888.20	2.04	0.96	229	634,870	0.14
Chung-Nam area	389	459.47	2.44	0.92	316	2,611,283	0.15
Chon-Buk area	220	574.07	2.76	1.16	271	723,118	0.14
Chon-Nam area	464	487.55	1.42	0.56	161	1,446,636	0.15
Gyeong-Buk area	448	452.78	1.26	0.58	257	2,502,368	0.16
Gyeong-Nam area	627	148.96	1.38	0.71	641	4,427,415	0.20

Table 5. Characteristics of structure by population service area in 2010

population service areas	N	HHI	Number of beds in clinic per 1000 persons	Number of doctors per 1000 persons	Population density	Tax per 1,000,000won	Education level
Capital area	5219	108.32	0.70	0.59	2508	17,566,324	0.34
West Gyeong-Gi area	2246	203.91	1.95	1.05	6018	5,527,400	0.28
South Gyeong-Gi area	1543	87.20	1.94	1.39	3987	4,435,583	0.29
Kang-Won area	589	875.09	2.08	0.89	89	1,222,509	0.21
Chung-Buk area	518	674.61	1.99	1.13	243	1,257,957	0.22
Chung-Nam area	1463	425.62	2.49	1.09	342	3,122,884	0.24
Chon-Buk area	857	449.22	2.56	1.46	260	1,296,431	0.24
Chon-Nam area	1649	317.28	1.63	0.94	149	2,522,230	0.24
Gyeong-Buk area	2187	273.03	1.36	0.83	254	3,845,402	0.24
Gyeong-Nam area	3606	148.44	1.54	1.08	655	7,602,490	0.29

4.2. Linear mixed-model analysis

Tables 6, 7, and 8 show the result of a linear mixed-model analysis. The association between socioeconomic characteristics of the market and HHI in 2002 and 2010 are indicated in Table 6. Population density and education level showed a negative association with the HHI ($p < .001$), whereas tax showed a positive association with it ($p < .001$). The result indicated that hospitals considered population an important factor for location (Table 6).

Table 6. Linear mixed model: association of market socioeconomic characteristics with the HHI in 2002 and 2010

	2002		2010	
	β	p-value	β	p-value
<u>Socioeconomic characteristics of the market</u>				
Population density	-0.053	<.0001	-0.048	<.0001
Tax(per 1,000,000won)	0.271	<.0001	0.131	<.0001
Education level	-5.158	<.0001	-4.357	<.0001

Table 7 shows the results of the linear mixed-model analysis for charges. First, the association between charges and the HHI is shown in the table. This value has increased significantly over the period 2002–2010 (β = 103.17, $p < .0001$ in 2002; β = 116.52, $p < .0001$ in 2010). Furthermore, the association between charges and patient characteristics are shown in Table 7. Charges were higher for patients older than 40 but younger than 65 compared with patients less than 40 years of age in both 2002 and 2010 (β = 559.57, $p < .0001$ in 2002; β = 374.08, $p < .0001$ in 2010). On the other hand, patients 65 years of age or older showed an increased association with higher charges in

2002–2010 (β = 382.08, p < .0001 in 2002; β = 845.28, p < .0001 in 2010). In addition, charges were significantly higher for patients with comorbidity (β = 1,296.72, p < .0001 in 2002; β = 1,002.74, p < .0001 in 2010). Total charges showed a significant association with surgery procedures (β = 4,649.86, p < .0001 in 2002; β = 4,296.34, p < .0001 in 2010).

The association between charges and hospital characteristics are shown in Table 7. Total charges were significantly lower for small hospitals compared with teaching or general hospitals in 2002 (β = -266.81, p < .0001) but higher in 2010 (β = 221.25, p < .0001). Charges were higher for private hospitals compared with public hospitals, and the association between charges and hospital ownership status increased over the period 2002–2010 (β = 333.22, p = 0.0044 in 2002; β = 181.21, p < .0001 in 2010). On the other hand, the number of doctors was positively associated with charge amount (β = 432.06, p < .0001 in 2002; β = 418.10, p < .0001 in 2010).

Finally, Table 7 shows the association between charges and regional characteristics. A higher number of beds in the clinic (per 1,000 persons) led to higher charges in 2002 (β = 303.94, p < .0001) but lower charges in 2010 (β = -123.88, p < .0001). More doctors (per 1,000 persons) showed a significant association with lower charges in 2002 (β = -0.415, p < .0001), whereas they led to higher charges in 2010 (β = 418.81, p < .0001).

Table 7. Linear mixed model: association between the HHI and charges (in 1,000 won) in 2002 and 2010

	2002		2010	
	β	p-value	β	p-value
Main interest				
HHI(by 100 points)	103.17	<.0001	116.52	<.0001
Patient-level				
Gender				
Male				
Female	274.69	<.0001	90.4910	<.0001
Age				
Less than 40				
40~64	559.57	<.0001	374.08	<.0001
65 and more	382.08	<.0001	845.28	<.0001
Income				
Medical aid				
20% and less	473.98	0.0002	549.43	<.0001
21~40%	611.04	<.0001	353.22	<.0001
41~60%	289.15	0.0199	541.90	<.0001
61~80%	231.23	0.0618	447.86	<.0001
81% and more	291.22	0.0187	258.83	<.0001
Comorbidity				
No				
Yes	1296.72	<.0001	1002.74	<.0001
Procedure				
Nonsurgery				
Surgery	4649.86	<.0001	4296.34	<.0001
Hospital-level				
Hospital classification				
Teaching hospital or general hospital				
Small hospital	-266.81	<.0001	221.25	<.0001
Ownership status				
Public				
Private	333.22	<.0001	181.21	<.0001
Number of beds				
30~300				
301~500	-400.54	<.0001	-115.47	<.0001
501~1000	-254.03	<.0001	-84.47	<.0001
1001~1500	-457.94	<.0001	-315.11	<.0001
1500 and more	-624.61	<.0001	-106.82	<.0001
Number of doctors	432.06	<.0001	418.10	<.0001

Table 7. (continued)

	2002		2010	
	β	p-value	β	p-value
CT				
No				
Yes	-714.49	<.0001	-114.93	<.0001
MRI				
No				
Yes	-116.78	0.0005	457.23	<.0001
Regional-level				
Number of beds in clinic (per 1000 persons)	303.94	<.0001	-123.88	<.0001
Number of doctors (per 1000 persons)	-32.16	0.6770	418.81	<.0001

The results of the linear mixed-model analysis on LOS are shown in Table 8. First, the table shows the association between LOS and the HHI. This figure decreased in the period 2002–2010 ($\beta = 0.89$, $p < .0001$ in 2002; $\beta = 0.25$, $p < .0001$ in 2010). Table 8 also shows the association between LOS and patient characteristics. LOS for females was higher than that for males in 2002 and 2010 ($\beta = 0.49$, $p < .0001$ in 2002; $\beta = 0.43$, $p < .0001$ in 2010). The association between LOS and age increased with charges in both years, and higher income levels showed a significant association with lower LOS in 2010. In addition, LOS showed a significant association with comorbidity ($\beta = 5.37$, $p < .0001$ in 2002; $\beta = 4.79$, $p < .0001$ in 2010). LOS was significantly higher for patients undergoing surgery procedures ($\beta = 6.04$, $p < .0001$ in 2002; $\beta = 11.02$, $p < .0001$ in 2010).

Next, the association between LOS and hospital characteristics is shown in Table 8. LOS was significantly lower for small hospitals than for teaching or general hospitals in 2002 and 2010 ($\beta = -2.01$, $p < .0001$ in 2002; $\beta = -0.72$, $p < .0001$ in 2010). The association between LOS and number of beds showed a different distribution than that between number of beds and charges. That is, the LOS fluctuated with the number of beds in 2010. According to the theory of economies of scale, cost falls when hospital size increases. Furthermore, the theoretical relationship between number of beds and hospital cost is U-shaped (Feldstein, 2004). Thus, the theory implies that the association between LOS and number of beds might be curved shape. On the other hand, the increased number of doctors had a negative association with LOS (β = -0.016, p = 0.002 in 2002; β = -0.009, p = 0.001 in 2010).

Finally, the table shows the association of LOS with regional characteristics. More beds in a clinic (per 1,000 persons) showed a negative association with LOS in 2002 (β = -0.36, p = 0.0243). In addition, an increase in the number of doctors (per 1,000 persons) led to a longer LOS while the association between the number of doctors and LOS decreased over time (β = 1.24, $p < .0001$ in 2002; β = 0.37, p = 0.0230 in 2010).

Table 8. Linear mixed model: the association of the HHI with LOS in 2002 and 2010

	2002		2010	
	Β	p-value	β	p-value
Main interest				
HHI(by 100 points)	0.89	<.0001	0.25	<.0001
Patient-level				
Gender				
Male				
Female	0.49	<.0001	0.43	<.0001
Age				
Less than 40				
40~64	0.94	<.0001	1.08	<.0001
65 and more	2.09	<.0001	1.87	<.0001
Income				
Medical aid				
20% and less	-0.56	0.2608	-1.61	<.0001
21~40%	-0.28	0.5697	-2.78	<.0001
41~60%	-0.37	0.4527	-1.69	<.0001
61~80%	-1.18	0.0172	-2.35	<.0001
81% and more	-1.00	0.0444	-3.15	<.0001
Comorbidity				
No				
Yes	5.37	<.0001	4.79	<.0001
Procedure				
Nonsurgery				
Surgery	6.04	<.0001	11.02	<.0001
Hospital-level				
Hospital classification				
Teaching hospital or general hospital				
Small hospital	-2.01	<.0001	-0.72	<.0001
Ownership status				
Public				
Private	1.76	<.0001	-0.56	<.0001
Number of beds				
30~300				
301~500	0.04	0.8099	3.44	<.0001
501~1000	1.91	<.0001	1.86	<.0001
1001~1500	3.39	<.0001	1.78	<.0001
1500 and more	0.07	0.7496	2.90	<.0001
Number of doctors	-0.16	0.0008	-0.51	<.0001

Table 8. (continued)

	2002		2010	
	B	p-value	B	p-value
CT				
No				
Yes	0.17	0.6320	0.19	0.0003
MRI				
No				
Yes	-0.35	0.0081	0.91	<.0001
Regional-level				
Number of beds in clinic (per 1000 persons)	-0.36	0.0243	0.19	0.1182
Number of doctors (per 1000 persons)	1.24	<.0001	0.37	0.0230

4.3. Subgroup analysis

4.3.1. Linear mixed-model analysis for DLS disease without comorbidity

This study conducted a linear mixed model for DLS disease without comorbidity. Tables 9 and 10 show the association of the HHI with charges and LOS for patients without comorbidity in 2002 and 2010. The association between the HHI and charges (in 1,000 won) in 2002 and 2010 is indicated in Table 9. This association increased significantly over the period (β = 42.08, p = 0.0005 in 2002; β = 308.24, p < .0001 in 2010), similar to the association between the HHI and higher charges as in Table 7. However, charges were lower for patients 65 years of age or older without comorbidity than for others (β = -278.99, p < .0001 in 2002; β = -75.32, p < .0001 in 2010). The result differed from that for all patients with DLS disease. Total charges showed a significant association with surgery procedures (β = 7,655.00, p < .0001 in 2002; β = 4,175.84, p < .0001 in 2010), and total charges for DLS patients without comorbidity admitted to small hospitals were higher than those admitted to teaching or general hospitals in 2002 and 2010 (β = 309.47, p < .0001 in 2002; β = 375.15, p < .0001 in 2010).

Table 9. Linear mixed model: association of the HHI with charges (in 1,000 won) for patients without comorbidity in 2002 and 2010

	2002		2010	
	B	p-value	B	p-value
Main interest				
HHI(by 100 points)	42.08	0.0005	308.24	<.0001
Patient-level				
Gender				
Male				
Female	-159.28	<.0001	-134.14	<.0001
Age				
Less than 40				
40~64	-25.02	0.0768	33.83	<.0001
65 and more	-278.99	<.0001	-75.32	<.0001
Income				
Medical aid				
20% and less	-40.21	0.6630	488.95	<.0001
21~40%	175.86	0.0544	795.59	<.0001
41~60%	234.54	0.0104	485.83	<.0001
61~80%	-89.11	0.3270	495.71	<.0001
81% and more	10.94	0.9043	405.31	0.0002
Procedure				
Nonsurgery				
Surgery	7655.00	<.0001	4175.84	<.0001
Hospital-level				
Hospital classification				
Teaching hospital or general hospital				
Small hospital	309.47	<.0001	375.15	<.0001
Ownership status				
Public				
Private	-1652.80	<.0001	461.69	<.0001

Table 9. (continued)

	2002		2010	
	B	p-value	B	p-value
Number of beds				
30~300				
301~500	-103.46	0.0119	88.09	<.0001
501~1000	-105.92	0.0060	149.24	<.0001
1001~1500	137.81	0.0017	-310.13	<.0001
1500 and more	-0.24	0.9963	493.50	<.0001
Number of doctors	140.99	<.0001	233.81	<.0001
CT				
No				
Yes	107.28	0.0695	-52.47	0.0001
MRI				
No				
Yes	19.85	0.4847	-43.57	0.0022
Regional-level				
Number of beds in clinic (per 1000 persons)	-18.46	0.5716	-665.48	<.0001
Number of doctors (per 1000 persons)	-620.47	<.0001	923.44	<.0001

Table 10 shows the association of the HHI with LOS for patients without comorbidity in 2002 and 2010. The HHI showed a significant association with LOS in 2010 (β = 0.40, p < .0001). LOS was lower for patients 65 years of age or older without comorbidity compared with patients less than 40 years of age (β = -1.50, p < .0001 in 2002; β = -0.86, p < .0001 in 2010). For patients without comorbidity, LOS was lower for patients 65 years of age compared with patients 40 years of age or younger. However, for all patients, LOS was higher for the former group than for the latter one. LOS was significantly higher for surgery procedures in both years (β = 9.48, p = 0.0002 in 2002; β = 8.32, p = 0.0442 in 2010).

Table 10. Linear mixed model: association of the HHI with LOS for patients without comorbidity in 2002 and 2010

	2002		2010	
	β	p-value	β	p-value
Main interest				
HHI(by 100 points)	0.02	0.7453	0.40	<.0001
Patient-level				
Gender				
Male				
Female	-0.48	<.0001	-0.55	<.0001
Age				
Less than 40				
40~64	-0.40	<.0001	-0.09	0.0100
65 and more	-1.50	<.0001	-0.86	<.0001
Income				
Medical aid				
20% and less	0.37	0.3056	2.05	<.0001
21~40%	0.28	0.4239	3.42	<.0001
41~60%	1.27	0.0003	2.03	<.0001
61~80%	-0.14	0.6965	1.94	<.0001
81% and more	0.36	0.3012	1.73	0.0004
Procedure				
Nonsurgery				
Surgery	9.48	0.0002	8.32	0.0442
Hospital-level				
Hospital classification				
Teaching hospital or general hospital				
Small hospital	-0.37	0.0033	0.92	<.0001
Ownership status				
Public				
Private	-4.70	<.0001	2.53	<.0001

Table 10. (continued)

	2002		2010	
	β	p-value	β	p-value
Number of beds				
30~300				
301~500	-0.45	0.0048	1.97	<.0001
501~1000	-0.17	0.2595	1.36	<.0001
1001~1500	0.11	0.5005	0.32	0.0055
1500 and more	-0.05	0.7992	2.24	<.0001
Number of doctors	-0.06	0.1293	0.12	<.0001
CT				
No				
Yes	0.23	0.3241	-0.37	<.0001
MRI				
No				
Yes	-1.29	<.0001	-0.80	<.0001
Regional-level				
Number of beds in clinic (per 1000 persons)	1.24	<.0001	-1.52	<.0001
Number of doctors (per 1000 persons)	-4.03	<.0001	2.42	<.0001

4.3.2. Linear mixed-model analysis for DLS disease without comorbidity depending on the number of beds

We conducted a linear mixed-model analysis for patients without comorbidity using the number of beds divided into 300 beds or less and more than 300 beds. Tables 11–14 show the results of our linear mixed-model analysis depending on the number of beds. The association between HHI and charges (in 1,000 won) for hospitals with 300 beds or less in 2002 and 2010 are indicated in Table 11. Lower competition (i.e., higher HHI) showed a significant association with lower charges for hospitals with 300 beds or less in 2002 and 2010 (β = -39.63, p = 0.0086 in 2002; β = -144.99, p < .0001 in 2010). In addition, the negative association between the HHI and charges for hospitals with 300 beds or less increased significantly between 2002 and 2010. Table 12 shows the association between the HHI and charges for hospitals with more than 300 beds in 2002 and 2010. However, lower competition (higher HHI) showed an association with higher charges for hospitals with more than 300 beds in 2002 and 2010 (β = 52.68, p = 0.0089 in 2002; β = 881.77, p < .0001 in 2010). Furthermore, the association between the HHI and charges for such hospitals increased significantly between 2002 and 2010. The association between the HHI and LOS for hospitals with 300 beds or less in 2002 and 2010 is shown in Table 13. Lower competition (higher HHI) showed a significant association with shorter LOS for hospitals with 300 beds or less in 2002 and 2010 (β = -0.12, p = 0.0462 in 2002; β = -0.69, p < .0001 in 2010). In addition, the association between the HHI and LOS for such hospitals increased between 2002 and 2010. Table 14 shows the association between the HHI and LOS for hospitals with more than 300 beds in

2002 and 2010. Lower competition (higher HHI) showed a significant association with shorter LOS for hospitals with more than 300 beds in 2002 (β = -0.19, p = 0.0105), but lower competition (higher HHI) showed a significant association with longer LOS for hospitals with more than 300 beds in 2010 (β = 1.64, $p < .0001$).

Table 11. Linear mixed model: the association between the HHI and charges (in 1,000 won) for hospitals with 300 beds or less in 2002 and 2010

	2002		2010	
	B	p-value	β	p-value
Main interest				
HHI(by 100 points)	-39.63	0.0086	-144.99	<.0001
Patient-level				
Gender				
Male				
Female	-195.93	<.0001	-117.45	<.0001
Age				
Less than 40				
40~64	-185.33	<.0001	-18.83	0.0004
65 and more	-277.36	<.0001	-138.98	<.0001
Income				
Medical aid				
20% and less	109.58	0.7934	308.10	0.0002
21~40%	419.15	0.3164	392.61	<.0001
41~60%	36.52	0.9304	333.30	<.0001
61~80%	143.30	0.7318	328.32	<.0001
81% and more	81.79	0.8449	276.81	0.0009
Hospital-level				
Number of doctors	140.12	<.0001	20.02	<.0001
Regional-level				
Number of beds in clinic (per 1000 persons)	247.70	<.0001	156.02	<.0001
Number of doctors (per 1000 persons)	-882.47	<.0001	0.50	0.9882

Table 12. Linear mixed model: the association between the HHI and charges (in 1,000 won) for hospitals with more than 300 beds in 2002 and 2010

	2002		2010	
	B	p-value	β	p-value
Main interest				
HHI(by 100 points)	52.68	0.0089	881.77	<.0001
Patient-level				
Gender				
Male				
Female	-153.78	<.0001	-182.83	<.0001
Age				
Less than 40				
40~64	146.62	<.0001	139.69	<.0001
65 and more	-319.14	<.0001	-51.15	0.0510
Income				
Medical aid				
20% and less	68.01	0.5212	830.62	0.0004
21~40%	185.20	0.0765	1452.12	<.0001
41~60%	706.56	<.0001	727.99	0.0019
61~80%	-23.09	0.8233	770.40	0.0010
81% and more	248.79	0.0161	693.14	0.0031
Hospital-level				
Number of doctors	127.96	<.0001	353.44	<.0001
Regional-level				
Number of beds in clinic (per 1000 persons)	-296.98	<.0001	-1470.41	<.0001
Number of doctors (per 1000 persons)	-331.42	0.0015	1501.41	<.0001

Table 13. Linear mixed model: the association between the HHI and the LOS for hospitals with 300 beds or less in 2002 and 2010

	2002		2010	
	β	p-value	β	p-value
Main interest				
HHI(by 100 points)	-0.12	0.0462	-0.69	<.0001
Patient-level				
Gender				
Male				
Female	-0.25	0.0002	-0.53	<.0001
Age				
Less than 40				
40~64	-0.72	<.0001	-0.21	<.0001
65 and more	-1.10	<.0001	-1.13	<.0001
Income				
Medical aid				
20% and less	3.27	0.0536	1.07	0.0802
21~40%	3.07	0.0699	1.86	0.0023
41~60%	3.64	0.0319	1.08	0.0774
61~80%	3.16	0.0617	1.02	0.0962
81% and more	3.04	0.0731	0.86	0.1599
Hospital-level				
Number of doctors	-0.65	<.0001	-0.86	<.0001
Regional-level				
Number of beds in clinic (per 1000 persons)	2.60	<.0001	-0.05	0.7773
Number of doctors (per 1000 persons)	-5.81	<.0001	1.05	<.0001

Table 14. Linear mixed model: the association between the HHI and LOS for hospitals with more than 300 beds in 2002 and 2010

	2002		2010	
	β	p-value	β	p-value
Main interest				
HHI(by 100 points)	-0.19	0.0105	1.64	<.0001
Patient-level				
Gender				
Male				
Female	-0.85	<.0001	-0.61	<.0001
Age				
Less than 40				
40~64	-0.07	0.4293	0.08	0.3198
65 and more	-1.80	<.0001	-0.68	<.0001
Income				
Medical aid				
20% and less	0.44	0.2568	3.39	<.0001
21~40%	0.74	0.0531	5.48	<.0001
41~60%	2.14	<.0001	3.18	<.0001
61~80%	-0.07	0.8476	3.02	0.0002
81% and more	0.83	0.0275	2.94	0.0002
Hospital-level				
Number of doctors	0.17	<.0001	0.43	<.0001
Regional-level				
Number of beds in clinic (per 1000 persons)	0.07	0.6810	-1.95	<.0001
Number of doctors (per 1000 persons)	-3.46	<.0001	1.29	0.0026

5. Discussion

5.1. Discussion on the study methods and limitations

There are several limitations associated with this study. First, although this study attempted to observe changes in the effects of market competition by reviewing two discrete periods (i.e., 2002 and 2010), it has a cross-sectional study design. Thus, there is a causal inference relationship. Second, only patients with DLS disease were included in this study; thus, the actual hospital market competition might be under- or overestimated. Furthermore, because diagnosis codes higher than four digits were inaccurate, assigning an adjustment weight to comorbidity level was not possible. Thus, this study used an indicator for whether comorbidity existed as its severity adjustment. Future studies may use the Charlson Comorbidity Index (CCI) for severity adjustments. Another limitation is that hospital financial statements were not included in the data, which may have influenced the outcome variables of this study. In addition, our definition of the hospital market may be a significant limitation of this study. Because 10 health service areas are the only official classification of hospital markets, this study used these 10 health service areas to define hospital markets and to adjust regional-level variables; however, using these health service areas may have weakened our findings. Lastly, a lack of data on hospital bed occupancy rates limited our analysis of the effects of hospital competition on charges and LOS. Therefore, this study grouped hospitals by number of beds. Hospital sizes were divided into 300 beds or less (small hospital) and more than 300 beds (large hospital) in this study. No official classification of hospital size exists, but the point of

300 beds is generally used for the standard classification of hospital size, which is the less-refined approach used in this study. Future works may apply the more refined approach of hospital bed occupancy rate to improve on our paper. Despite these limitations, this is an important empirical study for the evaluation of the influence of hospital market competition on charges and LOS.

5.2. Discussion of the results

This paper examined the influence of hospital competition on charges and LOS for DLS disease. Charges and LOS are considered an indicator of hospital efficiency (OECD, 2012). Our finding that increased hospital competition is related to lower charges and shorter LOS is similar to the previous studies of Melnick and Zwanziger (1988), Melnick et al. (1992), Propper (1996), Rivers and Fottler (2004), and Park (2006). In addition, the results of this study indicate that the magnitude of the effects of market competition on charges and LOS increased between 2002 and 2010. These findings were conceptualized using the S‑C‑P framework.

The results of the subgroup analysis for patients without comorbidity and those of analysis for all patients pointed in the same direction. After excluding comorbidity, the effects of the HHI on charges and LOS were low in 2002. However, these effects for patients without comorbidity increased in 2010.

In addition, this study conducted an analysis for patients without comorbidity by grouping the number of beds into 300 beds or less and more than 300 beds. For hospitals with 300 beds or less, higher competition is associated with increases in charges and LOS in both 2002 and 2010. This result showed that market competition did not lead to efficiency for small hospitals. Moreover, the magnitude of the side effects of market competition increased between 2002 and 2010. By contrast, in hospitals with more than 300 beds, higher market competition reduced charges over time. Furthermore, the association between the HHI and charges increased between 2002 and 2010. In terms of LOS for large hospitals, increased market competition in 2002 led to longer LOS but that in 2010 led to shorter LOS. During the period analyzed in this study, there have been efforts to reduce the average LOS in Korea. According to the "OECD Health Data 2014" report, Korea reduced its average LOS from 17.5 days in 2008 to 16.1 days in 2012. The average LOS of 16.1 days in Korea is much longer than the OECD average of 7.4 days, but the reduction in average LOS of 1.4 days in Korea was greater than that of the OECD average of 0.5 days between 2008 and 2012 (OECD, 2014). In addition, since the mid-2000s, enhancing the benefit coverage for national health insurance has affected the centralization of patients to large hospitals (KIHASA, 2013). The concentration of patients in large hospitals led to a decrease in LOS in large hospitals. These changes might have affected the association between the HHI and LOS for hospitals with more than 300 beds.

6. Conclusion

This study found that higher competition is related to lower hospital charges and LOS. The results of this study support the notion that competition leads to improved efficiency. Between 2002 and 2010, overall changes in the market structure may have affected the relationship between competition and DLS treatment outcomes (e.g., charges and LOS). However, improved efficiency through market competition was not observed among small hospitals, which raises concerns for policymakers. It is suggested that policy analysts and researchers continue to monitor the potential adverse efficiency of market competition, particularly among small facilities.

Reference

Baker L. Measuring competition in health care markets. Health Serv Res 2001;36:223–251.

Bederman SS, Kreder HJ, Weller I, Finkelstein JA, Ford MH, Yee AJ. The who, what and when of surgery for the degenerative lumbar spine: a population-based study of surgeon factors, surgical procedures, recent trends and reoperation rates. Can J Surg 2009;52(4):283-290.

Burgess J F. Jr., Carey K, Young GJ. The effect of network arrangements on hospital pricing behavior. Journal of Health Economics 2005;24(2):391-405.

Burns LR, Gimm G, Nicholson S. The financial performance of Integrated Health Organizations (IHOs). Journal of Healthcare Management 2005;50(3):191-213.

Chang DC, Shiozawa A, Nguyen LL, Chrouser KL, Perler BA, Freischlag JA, Colombani PM, Abdullah F. Cost of inpatient care and its association with hospital competition. J Am Coll Surg. 2011;212:12-19.

Davis CS. Statistical methods for the analysis of repeated measurements. 3rd ed. San Diego: Springer, 2002.

Dranove D, Shanley M, Simon C. Is Hospital competition wasteful? Rand J Econ 1992;23(2):247-262.

Dranove D, Shanley M, White WD. Price and concentration in hospital markets: The switch from patient-driven to payer-competition. Journal of Law and Economics 1993;36:179-204.

Dranove D, White WD. Recent theory and evidence on competition in hospital markets. J

Econ and Manag Strategy 1994;3(1):169-209.

Econex. Quantitative techniques in competition policy-the Elzinga-Hogarty Test. 2006 May;3.

Elzinga K, Hogarty T. The problem of geographic market delineation in antimerger suits. Antitrust Bull 1973;18:45–81.

Feldstein PJ. Health care economics. 6th ed. New York: Thomson Delmar Learning, 2004.

Fournier GM, Mitchell JM. Hospital costs and competition for services: a multiproduct analysis. Rev Econ Stat 1992;74:627-634.

Garnick D, Luft H, Robinson J, Tetreault J. Appropriate measures of hospital market areas. Health Serv Res 1987;22:69–89.

Gaynor M, Vogt W. Antitrust and competition in health care markets. Handbook of Health Economics 2000 April:1-89.

Gaynor M, Vogt W. Competition among hospitals. Rand J Econ 2003;34:764–785.

Gaynor M. What do we know about competition and quality in health care markets? CMPO Working Paper 2006;6(151):1-42.

Gresenz CR, Rogowski J, Escarce JJ. Updated variable-radius measures of hospital competition. Health Serv Res 2004;39(2):417-30.

Health Insurance Review & Assessment Service. Study of status and trend for development of evaluation index for spine surgery, 2007. (Korean)

Health Insurance Review & Assessment Service. Spinal surgery outcome study: Recurrence in surgical patients, 2009. (Korean)

Health Insurance Review & Assessment Service. Study of medical care utilization for spine surgery patients, 2014. (Korean)

Hearld LR, Alexander JA, Fraser I, Jiang HJ. Review: How do hospital organizational structure and processes affect quality of care?: a critical review of research methods. Med Care Res Rev 2008;65:259-299.

Held PJ, Pauly MV. Competition and efficiency in the end stage renal disease program. Journal of Health Economics 1983;2(2):95-118.

Hirth RA, Chernew ME, Orzol SM. Ownership, competition, and the adoption of new technologies and cost-saving practices in a fixed-price environment. Inquiry 2000;37:282-294.

Jo CI, Lim JY, Lee SY. The effect of the degree of competition of the hospital market regions on clinic's rate of antibiotics prescription. KDI. 2008;30(2):129-155. (Korean)

Joscow PL. The effect of competition and regulation on hospital bed and the reservation quality of the hospital. Bell Journal of Economics. 1980;11(2):421-447.

Kassirer JP. Managed care and the mortality of the marketplace. New England Journal of Medicine 1995;333(1):50–52

Kessler DP, McClellan MB. Is hospital competition socially wasteful? Q J Econ 2000;115:577-615.

Kim EJ. Clinics competitive impact of physician behavior-clinics in Seoul, Korea[master’s thesis]. Seoul: The Graduate School Seoul National University; 2012. (Korean)

Kim SJ, Park EC, Yoo KB, Kwon JA, Kim TH. The association of market competition with hospital charges, length of stay, and quality outcomes for patients with joint disease: a longitudinal study in Korea. Asia Pac J Public Health 2014;Apr:1-13.

Kleiner S, Lyons S, White WD. Provider concentration in Markets for Physician Services for Patients with Traditional Medicare. Health Management, Policy and Innovation 2012; 1(1): 3-18.

Koch E. Managing the medical arms race: innovation and public policy in the medical device industry by Susan Bartlett Foote. The business history review 1993;67(3):493-495.

Korea Institute for Health and Social Affairs. Improving the sustainability of healthcare delivery in line with NHI coverage enhancement, 2013. (Korean)

Korea Institute for Health and Social Affairs. An analysis of healthcare market competition in Korea, 2013. (Korean)

Luft HS, Maerki S. Competitive potential of hospitals and their neighbors. Contemporary Economic Policy 1984;3(2):89–102.

Luft HS, Robinson JC, Garnick DW, Maerki SC, McPhee SJ. The role of specialized clinical seervices in competition among hospitals. Inquiry 1986;23(Spring):83-94.

Luft H, Phibbs C, Garnick D, Robinson J. Rejoinder to Dranove and Shanley. Journal of Health Economics 1989;8:479–483.

Lee SB. Industrial organization. Yulgok, 2001. (Korean)

Lynk WJ. Nonprofit hospital mergers and the exercise of market power. Journal of Law and Economics 1995;38:437–61.

Mayo JW, McFarland DA. Regulation, market structure, and hospital costs. South Econ J 1989;55:559-569.

Melnick GA, Zwanziger J. Hospital behavior under competition and cost-containment policies. JAMA 1988;260(18):2669-75.

Melnick GA, Zwanziger J, Bamezai A, Pattison R. The effects of market structure and bargaining position on hospital prices. Journal of Health Economics 1992;11(3):217-33.

Mukamel DB, Zwanziger J, Tomaszewski KJ. HMO penetration, competition, and risk-adjusted hospital mortality. Health Serv Res 2001;36(6):1019-1035.

Mukamel DB, Zwanziger J, Bamezai A. Hospital competition, resource allocation and quality of care. BMC Health Serv Res 2002;2:10.

Noether M. Competition among hospitals. Journal of Health Economics 1988;7:259-284.

Noh JW, Kwon YD, Kang SW, Joo JS. Measures of hospital market competition by the Herfindahl Hirschman Index. Health Service Management Review 2007;1(1):13-22. (Korean)

Competition law & policy OECD. Competition in hospital services, 2012.

OECD. Health at a glance: Europe 2012, 2012.

OECD. OECD health statics 2014, 2014.

Palankaraya A, Yong J. On defining hospital markets and the effect of competition on quality: an extension of Elzinga-Hogarty and an application using hospital administration data. Melbourne Institute of Applied Economic & Social Research and the Centre for Microeconometrics the University of Melbourne 2009 March:1-29.

Park HK. Effects of hospital competition on the average length of stay and cost per inpatient day[dissertation]. Seoul: Seoul National University; 2006. (Korean)

Park HY, Kwon SM, Jung YH. Competition in the hospital service market and its impact on hospital behavior in Korea. Korean J. of Health Policy & Administration 2008;18(1):1-20.

Propper C. Agency and incentives in the NHS internal market. Social Science and Medicine 1996;40:1683–90.

Propper C. Market structure and prices: the responses of hospitals in the UK National Health Service to competition. J Public Econ 1996;61:307-335.

Propper C, Soderlund N. Competition in the NHS internal market: an overview of its effects on hospital prices and costs. Health Econ 1998;7:187-197.

Propper C, Burgess S, Green K. Does competition between hospitals improve the quality of care? Hospital death rates and the NHS internal market. J Public Econ. 2004;88:1247-1272.

Phibbs CS, Robinsons JC. A variable-radius measure of local hospital market structure. Health Serv Res 1993;28:313-324.

Reinhardt UE. Danger and opportunity: The new economics of health care. Bull N Y Acad Med 1996;73(2):538–60.

Rivers PA, Fottler MD. Do HMO penetration and hospital competition impact quality of hospital care? Health Services Management Research 2004;17:237-248.

Robinson JC, Luft HS. The impact of hospital market structure on patient volume, average length of stay, and the cost of care. Journal of Health Economics 1985;4:333-356.

Robinson JC, Luft HS. Competition and the cost of hospital care, 1972 to 1982. JAMA 1987;257:3241-3245.

Romeo AA, Wagner JL, Lee RH. Prospective reimbursement and the diffusion of new technologies in hospitals. Journal of Health Economics 1984;3:1–24.

Sakong J, Kown EJ. A Study of the Effect of Hospital Competition on the Behavior of the Health Care Suppliers. The Korean Association of Health Economics and Policy 2011;17(2):1-33. (Korean)

Sari N. Do Competition and Managed Care Improve Quality? Health Economics 2002;ll(7):571-584.

Scherer FM, Ross D. Industrial market structure and economic performance. 3rd ed. Boston: Houghton Mifflin, 1990.

Schneider JE, Li P, Klepser DG, Peterson NA, Brown TT, Scheffler RM. The effect of physician and health plan market concentration on prices in commercial health insurance markets. Int J Health Care Finance Econ 2008;8:13–26.

Stigler GJ. The new Palgrave dictionary of economics. 2nd ed. Basingstoke and Hampshire: Palgrave Macmillan, 2008.

USA Department of Commerce. Physician market power and medical-care expenditures. Bureau of E. 2012;April 26.

USA Department of Health and Human Services, National Center for Health Services Research and Health Care Technology Assessment. Competition among hospitals: market structure and its relation to utilization, costs, and financial position. 1985.

Vistnes G. Hospital mergers and antitrust enforcement. Journal of Health Politics, Policy, and Law 1995;20:175–190.

Vogt WB, Town R. How has hospital consolidation affected the price and quality of hospital care? RWJF Research Synthesis Project 2006;9.

Volpp KG, Williams SV, Waldfogel J, Silber JH, Schwartz S, Pauly MV. Market reform in

New Jersey and the effect on mortality from acute myocardial infarction. Health Services Research 2003;38(2):515-533.

William CH, Vogt WB, Town R. How has hospital consolidation affected the price and quality of hospital care? RWJF Research Synthesis Project 2006;9.

Wong HS, Zhan C, Mutter R. Do different measures of hospital competition matter in empirical investigations of hospital behavior? Review of Industrial Organization 2005;26:61–87.

Zwanziger J, Melnick G. The effects of hospital competition and the medicare PPS Program on hospital cost behavior in California. Journal of Health Economics 1988;7:301–320.

Zwanziger J, Melnick G, Mann J. Measures of hospital market structure: a review of the literature and a proposed approach. Socio-Economic Planning Science 1990;24:81–95.

Zwanziger J, Melnick G, Eyre K. Hospitals and antitrust: defining markets, setting standards. Journal of Health Politics, Policy, and Law 1994;19:423–447.

국문요약

병원시장 경쟁이 진료비 및 재원일수에 미치는 영향

국내에서 요추질환 환자의 의료이용과 진료비가 지속적으로 증가하고 있다. 게다가 병원형태와 재원일수에 따라 요추수술의 입원건당 진료비의 차이가 크다. 그 동안에 병원과 전문병원의 증가에 의한 경쟁 심화가 최근 요추수술 현황에 영향을 미쳤을 것이다. 하지만 아직 병원시장 경쟁이 병원 효율성에 영향을 미쳤을 것이라는 실증적 근거가 부족하다.

이 연구는 병원시장 경쟁이 진료비 및 재원일수와 관련이 있는지 분석하였다. 시장구조가 의료공급자의 행태에 영향을 미치고 궁극적으로 성과에 영향을 준다고 가정하는 산업조직론의 개념적 틀을 연구모형으로 적용하였다. 분석을 위해 2002년도, 2010년도 국민건강보험 표본코호트 자료와 2002년도, 2010년도 보건복지부·한국보건사회연구원 환자조사 퇴원환자자료를 바탕으로 퇴행성 요추질환 입원환자 총 24768명 (2002년 4891명, 2010년 19877명)을 대상으로 하였다. 경쟁은 HHI(Hirschmann-Herfindal Index)에 의해서 측정되었다. 시장구조-시장행태-시장성과 (S-C-P) 모형을 적용하여 혼란변수를 보정한 후, 병원 경쟁을 주요 독립변수로 진료비와 재원일수를 종속변수로 선형혼합모형을 이용하여 분석하였다.

퇴행성 요추환자의 총 진료비 평균은 2002년에 306,351원, 2010년에 250,723원이었고, 재원일수의 평균은 2002년 2.98일, 2010년 2.79일이었다. 선형혼합모형 분석 결과 HHI는 퇴행성 요추환자의 진료비 및 재원일수와 관련

이 있다. HHI가 증가할수록 2002년과 2010년에 퇴행성 요추질환 입원환자의 진료비(단위: 1000원)가 통계적으로 유의하게 증가했다. 또한 HHI가 증가할수록 2002년과 2010년에 해당질환 입원환자의 재원일수가 유의하게 증가하였다. 경쟁수준이 높을수록 진료비와 재원일수를 감소시켰다. 게다가 동반질환이 없는 환자들만을 대상으로 분석했을 때에도 앞서 분석한 결과와 같은 방향을 나타냈다. 300병상 이하의 병원에서는 경쟁 수준이 높을수록 2002년과 2010년에 진료비와 재원일수가 증가했다. 반면에, 300병상 초과 병원에서는 2002년과 2010년에 경쟁수준이 높을수록 진료비와 재원일수를 감소시켰다.

이러한 결과를 토대로 병원 경쟁과 같은 시장구조가 진료비, 재원일수 병원 효율성에 영향을 미친다는 결론을 내릴 수 있었다. 그러므로 병원성과에 영향을 주는 시장구조의 변화에 대한 정부의 관심이 요구된다. 또한 향후 경쟁이 환자 만족도와 같은 성과에 미치는 효과에 대한 보다 상세한 분석이 필요하다.

핵심어: 병원경쟁, Hirschmann-Herfindal Index, 진료비, 재원일수

Appendix A

Table A.1. Descriptive statistics: Patients without Comorbidity in 2002 and 2010

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Patient-level				
Charges[a]		88,078 ±270,863		99,096 ±334,106
Length of stay		1.78 ±2.08		1.82 ±2.32
Gender				
Male	1,114 (50.45)		2,259 (46.23)	
Female	1,094 (49.55)		3,441 (53.77)	
Age				
Less than 40	729 (33.02)		1,632 (25.50)	
40~64	1,135 (51.40)		3,152 (49.25)	
65 and more	344 (15.58)		1,616 (25.25)	

Table A.1. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Income				
Medical aid	6 (0.27)		14 (0.22)	
20% and less	252 (11.41)		798 (12.47)	
21~40%	341 (15.44)		860 (13.44)	
41~60%	398 (18.03)		1,155 (18.05)	
61~80%	536 (24.28)		1,518 (23.72)	
81% and more	675 (30.57)		2,055 (32.11)	
Procedure[b]				
Nonsurgery	20,660 (99.99)		71187 (100.00)	
Surgery	2 (0.01)		1 (0.00)	
Hospital-level				
The number of patients by hospital classification				
Teaching hospital or general hospital	1,361 (61.64)		2,522 (39.41)	
Small hospital	847 (38.36)		3,878 (60.59)	
The number of patients by ownership status				
Public	31 (1.40)		98 (1.53)	
Private	2,177 (98.60)		6,302 (98.47)	

Table A.1. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
The number of patients by bed size				
30~300	974 (44.11)		4,368 (68.25)	
301~500	150 (6.79)		395 (6.17)	
501~1000	675 (30.57)		1,304 (16.16)	
1001~1500	267 (12.09)		329 (5.14)	
1500 and more	142 (6.43)		274 (4.28)	
The number of doctors		147.85 ±192.68		116.24 ±258.72
The number of patients by existence of CT				
No	32 (1.45)		651 (10.17)	
Yes	2,176 (98.55)		5,749 (89.83)	
The number of patients by existence of MRI				
No	214 (9.69)		726 (11.34)	
Yes	1,994 (90.31)		5,674 (88.66)	

Table A.1. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Market structure				
HHI(by 100 points)		3.26 ±2.88		2.26 ±1.72
The number of beds in clinic (per 1000 persons)		1.55 ±0.67		1.51 ±0.60
The number of doctors (per 1000 persons)		0.68 ±0.20		0.94 ±0.27
Number of patients	2,208 (100)		6,400 (100)	

[a]Unit: Korean Won.

[b]Unit: number of surgery

Table A.2. Descriptive statistics: Patients without Comorbidity in small hospitals in 2002 and 2010

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
<u>Patient-level</u>				
Charges[a]		102,626 ±251,501		84,041 ±213,497
Length of stay		1.98 ±2.30		1.90 ±2.39
Gender				
Male	487 (48.94)		2,084 (46.10)	
Female	508 (51.06)		2,437 (53.90)	
Age				
Less than 40	369 (37.09)		1,266 (28.00)	
40~64	501 (50.35)		2,291 (50.67)	
65 and more	125 (12.56)		964 (21.32)	

Table A.2. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Income				
Medical aid	2 (0.20)		8 (0.18)	
20% and less	112 (11.26)		575 (12.72)	
21~40%	173 (17.39)		612 (13.54)	
41~60%	189 (18.99)		853 (18.87)	
61~80%	244 (24.52)		1,087 (24.04)	
81% and more	275 (27.64)		1,386 (30.66)	
Hospital-level				
The number of doctors		21.06 ±17.02		12.52 ±10.81
Market structure				
HHI(by 100 points)		3.22 ±2.92		2.26 ±1.70
The number of beds in clinic (per 1000 persons)		1.49 ±0.66		1.53 ±0.61
The number of doctors (per 1000 persons)		0.68 ±0.20		0.95 ±0.27
Number of patients	995 (100)		4,521 (100)	

[a]Unit: Korean Won.

Table A.3. Descriptive statistics: Patients without Comorbidity in large hospitals in 2002 and 2010

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Patient-level				
Charges[a]		76,041 ±284,169		127,999 ±495,951
Length of stay		1.60 ±1.85		1.61 ±2.11
Gender				
Male	647 (51.64)		987 (47.70)	
Female	606 (48.36)		1,082 (52.30)	
Age				
Less than 40	372 (29.69)		418 (20.20)	
40~64	656 (52.35)		950 (45.92)	
65 and more	225 (17.96)		701 (33.88)	

Table A.3. (continued)

	2002		2010	
	n(%)	Mean±SD	n(%)	Mean±SD
Income				
Medical aid	4 (0.32)		8 (0.39)	
20% and less	142 (11.33)		245 (11.84)	
21~40%	176 (14.05)		273 (13.19)	
41~60%	218 (17.40)		324 (15.66)	
61~80%	300 (23.94)		479 (23.15)	
81% and more	413 (32.96)		740 (35.77)	
Hospital-level				
The number of doctors		247.03 ±207.66		336.29 ±368.91
Market structure				
HHI(by 100 points)		3.29 ±2.82		2.28 ±1.79
The number of beds in clinic (per 1000 persons)		1.61 ±0.68		1.47 ±0.60
The number of doctors (per 1000 persons)		0.69 ±0.20		0.92 ±0.27
Number of patients	1,253 (100)		2,069 (100)	

[a]Unit: Korean Won.