원 저

Does Market Competition Reduce Hospital Charges & LOS for the Degenerative Lumbar Spinal Disease?: A Two-point Cross Sectional Study

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〈Abstract〉

병원시장 경쟁이 퇴행성 요추질환 환자의 진료비 및 재원일수에 미치는 영향

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Purpose: 요추질환 환자의 의료이용과 진료비가 지속적으로 증가하고 있다. 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.

Methodology: 본 연구는 2002년도, 2010년도 국민건강보험 표본코호트 자료와 보건복지부 · 한국보건사회연구원 환자조사 퇴원환자자료를 바탕으로 퇴행성 요추질환 입원환자 총 24,768명을 대상으로 하였다. 시장구조-시장행태-시장성 (S-C-P) 모형을 적용하여 혼란변수를 보정한 후, 환자수준, 병원수준 변수를 포함하여 다수준 혼합모형을 이용하여 분석하였다.

Findings: 병원경쟁이 증가할수록 퇴행성 요추질환 입원환자의 진료비 (β =57.5, p<.0001 in 2002; β =353.7, p <.0001 in 2010) 와 재원일수 (β =0.3, p<.0001 in 2002; β =0.9, p<.0001 in 2010) 가 감소하였으며, 그 정도는 2002년에 비해 2010년에 그 연관성의 정도가 더 크게 보였다. 그러나 병원경쟁이 진료비와 재원일수에 미치는 영향은 병원 규모에 따라 다르게 나타났다.

Practical implications: 이러한 결과를 토대로 병원 경쟁과 같은 시장구조가 진료비, 재원일수 등의 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.

Keywords: 병원경쟁, Hirschmann-Herfindahl Index, 진료비, 재원일수

Ⅰ. INTRODUCTION

In recent years, the socioeconomic cost for diseases of lumbar spine has increased dramatically [1, 2]. Health care utilizations and costs of this disease in South Korea (Korea henceforth) have

* 투고일자 : 2017년 07월 17일, 수정일자 : 2017년 08월 10일, 게재확정일자 : 2017년 08월 16일
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more than doubled during 2002-2007. Dramatic increases in hospital utilization for degenerative lumbar spine disease (DLSD) may have been driven in part by changing demographics, especially the rapid growth of older populations. The average annual rate of increase in spinal surgeries in the United States was 4.54% over the past 11 years, whereas Korea's was 25.36% during the past 3 years [3]. Moreover, the lumbar region accounts for most spinal surgeries according to health insurance claims [4].

Health care utilizations and costs of patients with DLSD in Korea have been increasing steadily. In addition, the charges for lumbar spinal surgery admission vary widely depending on the hospital type and average length of stay (LOS), which is much lengthier in Korea than elsewhere [5]. However, higher competition between hospitals owing to the increased number of general and specialized hospitals may have influenced recent DLSD treatment trends, resulting in fluctuating hospital efficiency. An Organization for Economic Co-operation and Development (OECD) committee discussed the role of hospital competition in healthcare expenditures in 2012 [6]. 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. By contrast, in Korea, the annual growth rate of such expenditures remains high [7]. Thus, using competition as a mechanism for costs, quantity and quality controls should be considered to resolve these increases in healthcare spending [8].

It is necessary to investigate long-term changes in competition to analyze hospitals' competitive behavior [9]. However, most studies have utilized short-term data. Therefore, we attempted to observe changes in the association of market competition with hospital performance by relating measures to two points in time (i.e., 2002 and 2010).

1. Hospital competition

Competition in the healthcare market has intensified over the past few decades [10-13]. Because the change over a decade in which the number health care facilities in Korea has increased dramatically 32.2% from 2000 to 2010, small hospitals have had financial problems and some of them begun to specialize to better compete [13]. These trends have increased in healthcare market in Korea and influenced healthcare utilization and cost. 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 [14]. However, hospital competition differs from competition in other industries as it is based on price and the profit maximizationprinciple [15]. Typically, competition leads to better performance in terms of quality improvements and price reductions. In contrast, in the medical industry, competition is often related to privatization. It can cause price fluctuations and deterioration of health outcomes [16].

Many studies have analyzed market competition and hospital efficiency. Studies using pre-1985 US data mostly proposed that competition may result in healthcare system inefficiencies [15, 17]. In particular, 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 [18]. Competition in the supply of high-tech services implied an association between

hospital competition and costs [19]. Some studies showed that treatment costs were higher in more competitive areas [12, 20]. However, following the introduction of diagnosis-related groups (DRGs) and managed care in the United States and the shift from non-price to price competition, high competition is expected to reduce the increasing rates of medical expenses [21, 22]. In this situation, growing competition may place strong pressure on cost reductions and improved efficiency of hospital care [23]. However, some studies have found that cost competition is associated with deteriorating health outcomes [24, 25], whereas other studies have doubted whether hospital competition is related to either treatment cost or hospital care quality [26, 27]. Concerning the ongoing debate, more studies are required [28]. In this study, we thus attempt to find the effects of hospital competition on efficiency.

2. Healthcare market in Korea

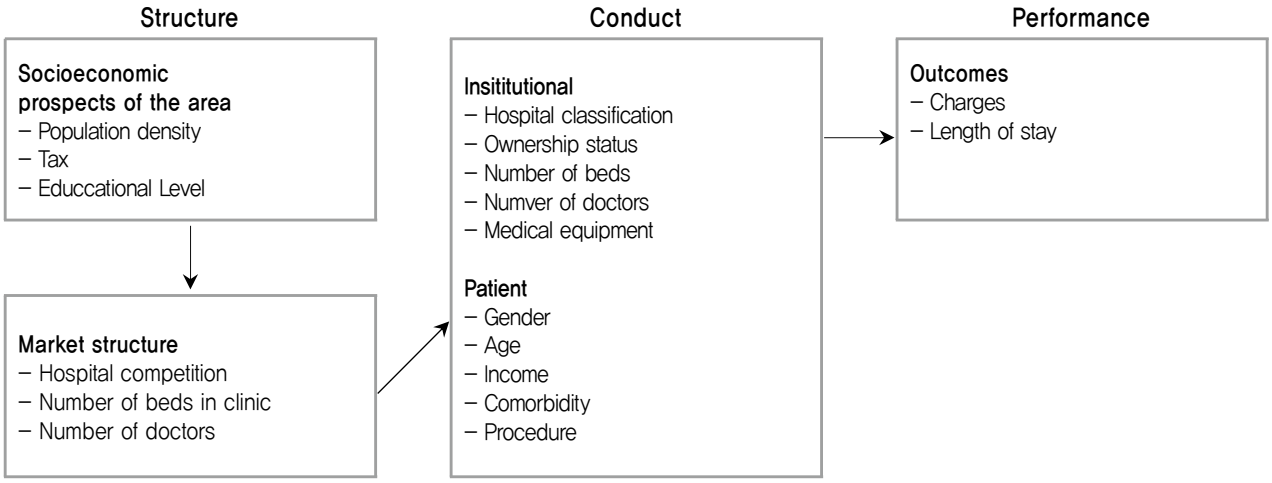
Unlike in the United States, Korea has a National Health Insurance System (NHIS) that provides universal health coverage with an average 20% copayment. Further, Korea has a fee-for-service (FFS) hospital payment system (excluding the DRGs, which cover seven disease groups). The FFS, which depends on treatment quantity, affects healthcare provider behavior. Moreover, when patients pay for part of the universal health coverage cost, 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 grouped into 10 healthcare service areas. In addition, the number of doctors and beds and other resources are under government control. As the effects of competition on hospital performance would differ by market structure, the effects in the United States differ from those in Korea.

While most Korean hospital competition studies used short-term data or factors at patient and hospital levels, the current study used medical claims data from nationwide representative sample in 2002 and 2010 as the main data as well as adjusted socioeconomic market characteristics (i.e., population density, taxes, and education level) and hospital market structure (i.e., number of beds and doctors).

3. Theoretical foundation

In the industrial organization field, market structure affects provider behaviors and eventually, outcomes [29]. The structure-conduct-performance (S-C-P) paradigm of industrial organization can be also applied to the healthcare industry. Thus, this study's conceptual framework is derived from the industrial organization field, in which the market structure (i.e., the number and distribution of hospitals, which are barriers to market entry) is assumed to affect hospital service provider behavior and eventually, the outcomes (Figure 1).

Many studies examining the impact of hospital market competition on patient outcomes have used the S-C-P theory as a mechanism [30, 31]. Furthermore, previous studies have indicated that outcomes depend on characteristics of multilevel factors (i.e., patients, hospitals, and socioeconomic environment characteristics) [23, 32]. Some have also suggested that competition effects differ depending on market structure [30, 33].



<Fig. 1> Modified S-C-P model

<Appendix table 1> Variables, definitions, and sources

Variable	Definition	Source
Outcome variables		
Charges	Charge per admission	NHIS
Length of stay (LOS)	Length of stay per admission	NHIS
Patient		
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
Institutional		
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
Hirschmann-Herfindahl Index(HHI)	Summing the squared market shares of each hospital in market (by 100 points)	KIHASA
Number of beds in clinic in each market	Average number of beds in clinic in each market (per 1000 persons)	KOSTAT
Number of doctors in each market	Average number of doctors in each marke t(per 1000 persons)	KOSTAT
Socioeconomic prospects of the area		
Population density	People per square kilometer	KOSTAT
Tax	Local tax (per 1,000,000won)	KOSTAT
Education level	College graduation rate	KOSTAT

Using the modified S-C-P framework, this study divided structure into socioeconomic characteristics and hospital market structure. In terms of the "structure", given the possibility that market competition could be endogenous, 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. The "conduct" construct

indicates hospital behavior and includes hospital and ownership types, number of beds and doctors, and technology, whereas the "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 [34].

Ⅱ. METHODS

1. Data source and study sample

We used medical claims data of 2002 and 2010 from the nationwide representative sample of National Health Insurance Service of Korea as well as the National Hospital Discharge Survey of Korea Institute for Health and Social Affairs (KIHASA) to calculate the Herfindahl-Hirshman Index (HHI) in 2002 and 2010. Variables for market structure were calculated using data from the Korea National Statistical Office (KOSTAT) (Appendix table 1).

Market structure variables were calculated using Korea National Statistical Office data. Only patients who were hospitalized with DLSD were included (4,891 persons in 2002 and 19,877 persons in 2010). In total, 2,208 patients were without comorbidity in 2002 and 6,400 in 2010 of which 995 in 2002 and 4,521 in 2010 were admitted to hospitals with 300 or less beds. Those admitted to hospitals with more than 300 beds numbered 1,267 in 2002 and 2,098 in 2010.

The study subjects included only those with DLSD. 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".

Nonoperative treatment including physical therapy and pain management is more common than operative treatment for DLSD. As operative and nonoperative treatments were both included in the analysis, the surgery types investigated were arthrodesis for spinal deformity, arthrodesis of spine, diskectomy, and laminectomy.

2. Outcome measures

Charges and LOS were considered in measuring hospital performance in both years. "charges" are measured as the sum of fee-for-services (FFS) claims for each admission, and "LOS" indicates the total number of inpatient days for each admission.

4. Covariates

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 and hospital market variables. The main independent variable was the HHI for hospital markets. The HHI is the standard method for measuring market competition. The HHI sums the squared market shares of each hospital in a market [9], and the market shares are usually calculated from the number of discharges [35]. Counting the number of hospitals is a simple method, but HHI is a preferred method because it reflects relative size of competitors and the distribution of market shares [36]. A lower HHI index presents a relatively unconcentrated market and more competitive. The scale of HHI can range from close to 0 to 10,000. To calculate it, 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 [35]. Following Kim, Lee and Oh (2013), we calculated the HHI along with patient discharge data for the residential zip code and institutional data for the hospital administrative district and the number of discharges [37]. Then, we divided the hospital market depending on the health service area to analyze the HHI. We divided regional-level variables by health service area, and the MOHW determined 10 health service areas reflecting past hospital utilization patterns. Socioeconomic variables include population density, tax, and education level. Hospital market variables include hospital competition level, number of beds in the clinic, and number of doctors.

5. Analytical approach

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 of market as independent variables and hospital competition level as the dependent variable. Although market level variables are generally considered as exogenous, we allow the possibility that the market competition variable could be endogenous. Thus we first tested the association of socioeconomic characteristics with market competition and then that of market competition with charges and LOS excluding socioeconomic characteristics. Then, we conducted a multilevel mixed model that included patient- and hospital-level variables in hierarchical data using hospital competition as the principle independent variable and charges and LOS as the dependent variables. In such methodology, we compared model specification by each model (null model, model 1=only adjusted patient-level, model 2=only adjusted hospital-level, and model 3=fully adjusted). We also compared intra-class correlation coefficient (ICC) to examine the reliability of each level variable for the outcome variable. The goodness of fit for mixed model was assessed using the (AIC) and -2 Res Log Likelihood. The lower value for AIC and -2 Res Log Likelihood indicated that it has a better model fitting. The equation for the multilevel mixed model is

For the year 2002 and 2010:

$$Yij=\alpha 0 + \alpha 1Wj+ \alpha\ 2Xij+\mu 0j + \varepsilon ij$$

Here, there is the outcome for patient i in hospital j (Yij), an intercept ($\alpha 0$), patient- and hospital-level regression coefficients ($\alpha 1$ and $\alpha 2$, respectively), patient- and hospital-level predictors (Xij and Wj, respectively), and patient- and hospital-level error terms (ε ij and $\mu 0$j, respectively). Because the number of doctors is skewed, a log transformation was applied to this variable. All individual patient-level and hospital-level data were included in our multilevel mixed model. SAS 9.4 was used for all analysis.

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 (small hospital) and more than 300 beds (large hospital).

Ⅲ. RESULTS

1. Patient, hospital, and market characteristics

As shown in Table 1, from 2002 to 2010, the average of charges decreased by 55.7 and the average LOS decreased by 0.19 days. Furthermore, the average of the outcome variables also decreased.

Patients over 65 years old increased from 22.0% in 2002 to 30.4% in 2010. The number of patients by income has no significant change, but income is positively correlated with the patient ratio. The ratio of patients with comorbidity increased from 63.8 in 2002 to 77.7 in 2010.

<Table 1> Descriptive statistics in 2002 and 2010

	2002		2010		
	n(%)	Mean±SD	n(%)	Mean±SD	p-value
Patient-level					
Charges[a]		306.4±1,060.7		250.7±783.7	0.001
Length of stay		3.0±4.9		2.8±4.3	0.017
Gender					
Male	2,188(44.7)		8,416(42.3)		0.002
Female	2,703(55.3)		11,461(57.7)		
Age					
Less than 40	1,259(25.7)		3,811(19.2)		<.0001
40~64	2,558(52.3)		10,022(50.4)		
65 and more	1,074(22.0)		6,044(30.4)		
Income					
Medical aid	12(0.3)		48(0.2)		0.045
20% and less	602(12.3)		2,745(13.8)		
21~40%	741(15.2)		2,820(14.2)		
41~60%	864(17.7)		3,606(18.1)		
61~80%	1,156(23.6)		4,498(22.6)		
81% and more	1,516(31.0)		6,160(31.0)		
Comorbidity					
No	1,772(36.2)		4,428(22.3)		<.0001
Yes	3,119(63.8)		15,449(77.7)		
Procedure					
Nonsurgery	4,815(98.5)		19,659(98.9)		
Surgery	76(1.6)		218(1.1)		
Hospital-level					
Hospital classification					
Teaching hospital or general hospital	163(33.8)		319(66.2)		<.0001
Small hospital	160(16.2)		831(83.9)		
Ownership status					
Public	6(13.3)		39(86.7)		0.217
Private	317(22.2)		1,111(77.8)		
The number of beds					
30~300	185(17.2)		889(82.8)		<.0001
301~500	44(26.3)		123(73.7)		
501~1000	68(38.4)		109(61.6)		
1001~1500	20(46.5)		23(53.5)		
1500 and more	6(50.0)		6(50.0)		
The number of doctors		157.4±208.0		91.6±221.8	<.0001
CT					
No	208(8.0)		230(92.0)		<.0001
Yes	303(24.8)		920(75.2)		
MRI					
No	108(18.4)		478(81.6)		0.010
Yes	215(24.2)		672(75.7)		

<able 1> (continued)

	2002		2010		
	n(%)	Mean±SD	n(%)	Mean±SD	p-value
Socioeconomic prospects of the area					
Population density		1,717.8±1,708.6		1,852.4±61,909	<.0001
Tax(per 1,000,000won)		5,544,045±4,796,299		6,029,569±1222509	<.0001
Education level		0.2±0.03		0.3±0.04	<.0001
Market structure					
HHI(by 100 points)		3.3±2.9		2.4±1.7	<.0001
The number of beds in clinic(per 1000 persons)		1.6±0.7		1.5±0.6	0.010
The number of doctors (per 1000 persons)		0.7±0.2		1.0±0.3	<.0001
Number of patients	4,891(100)		19,877(100)		

[a]Unit: US dollar. Costs converted from Korean won to US dollars according to annual average exchange rate.

<Table 2> Linear mixed model: association of market socioeconomic characteristics with the HHI in 2002 and 2010

	2002		2010	
	β	p-value	β	p-value
Socioeconomic characteristics of the market				
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

Next, the characteristics for number of patients by hospital are shown in Table 1. Of patients with DLSD, those admitted to teaching or general hospitals decreased by 26.4% in 2002-2010 but those admitted to small hospitals increased by 26.5%. The ratio of patients admitted to hospitals with more than 30 but fewer than 300 beds increased, 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, and the number of patients in hospitals with CT scanners or MRI machines decreased. 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 HHI distribution was extremely left-skewed. 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.

2. The association between socioeconomic characteristics of the market and HHI

As shown in Table 2, 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.

3. The association of the HHI with charges and LOS for patients without comorbidity

Table 3 shows the results of multilevel mixed model for the association between HHI and charges considering both patient and hospital-level variables. As indicated in the table, the association between the HHI and charges increased significantly over the period (β =57.5, $p < .0001$ in 2002; β =353.7, $p < .0001$ in 2010). harges showed a significant association with surgery procedures (β =4,025.9, $p < .0001$ in 2002; β =3,023.9, $p < .0001$ in 2010).

<Table 3> Multilevel mixed model: association of the HHI with chargesa for patients without comorbidity in 2002 and 2010

	2002				2010			
	Null	model 1	model 2	model 3	Null	model 1	model 2	model 3
Intercept	770.6***	731.7***	−838.2	−1364.9	700.5***	1024.8	−1604.1	−1387.6***
Patient-level								
Gender								
Male								
Female		−529.3***		−460.5***		−67.6***		−122.2***
Age								
Less than 40								
40~64		−294.8***		−505.2***		−269.0***		191.6***
65 and more		−86.0		−481.7***		293.1		749.2***
Income								
20% and less								
21~40%		180.7***		1503.8***		−403.3***		253.6***
41~60%		135.3		363.1***		98.5***		−201.9*
61~80%		253.7*		−83.3		78.0***		16.0
81% and more		115.1		276.5***		−360.9***		−172.3***
Procedure								
Nonsurgery								
Surgery		1740.5***		4025.9***		2027.9		3023.9***
Hospital-level								
Hospital classification								
Teaching hospital or general hospital								
Small hospital			321.9	644.0			−119.7	−124.1
Ownership status								
Public								
Private			−798.1	−553.9			283.8	286.5
Number of beds								
30~300								
301~500			−185.4	557.5			−491.7	−517.1
501~1000		548.8	1321.9			−709.5	−836.7	
1001~1500			1082.6	2082.0			−245.2	−434.1
1500 and more			727.3	1714.0			6.7	−235.9
Number of doctors			−5.0	−244.8			289.0*	302.0*
CT								
No								
Yes			756.0	823.3			146.0	65.9
MRI								
No								
Yes			−51.7	461.2			−220.0	−138.7
HHI (by 100 points)		8.2	57.5***			376.0***	353.7***	

<Table 3> (continued)

	2002				2010			
	Null	model 1	model 2	model 3	Null	model 1	model 2	model 3
Number of beds in clinic (per 1000 persons)								
Low			1323.7***	1950.1***			16.3	128.2***
Middle			778.0***	601.8***			535.7***	291.5***
High								
Number of doctors (per 1000 persons)								
Low			186.4*	−236.1			876.2***	517.4***
Middle			520.0***	773.7***			436.8***	198.4**
High								
Error variance								
Hospital-level	952974***	209551***	769525***	1317620***	572404***	200551***	701349***	683208***
Residual	851355***	213223***	804761***	585274***	630280***	154550***	542378***	683208***
ICC	0.52816	0.495657	0.488809	0.69243	0.475939	0.564772	0.563909	0.578514
Model fit								
−2 Res Log Likelihood	85545.2	83645.7	85245.3	83613.6	383249	377741.6	379759.6	377712.6
AIC	85551.2	83695.7	85279.3	83663.6	383255	377791.6	379793.6	377762.6

*** p<0.001, ** p<0.01, * p<0.05

Model 1=only adjusted patient-level, model 2=only adjusted hospital-level, and model 3=fully adjusted.

Table 4 shows the results of multilevel mixed model for the association of HHI and LOS. The HHI showed a significant association with LOS (β =0.3, p < .0001 in 2002; β =0.9, p<.0001 in 2010). LOS was lower for patients 65 years of age or older compared with patients less than 40 years of age (β =−1.0, p < .0001 in 2002; β =−0.4, p < .0001 in 2010). 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 =10.2, p < .0001 in 2002; β =9.6, p = 0.004 in 2010).

4. Multilevel mixed-model analysis for DLSD without comorbidity depending on the number of beds

Table 5 shows the results of our multilevel mixed-model analysis depending on the number of beds. For hospitals with 300 beds or less, higher HHI (i.e., lower competition) was associated with lower charges (in dollar) in 2002, but it was associated with higher charges (in dollar) in 2010. Higher HHI (i.e., lower competition) showed a significant association with longer LOS in 2002, but it became reversed in 2010: higher HHI (i.e., lower competition) was associated with shorter LOS.

On the other hand, for hospitals with more than 300 beds, higher HHI (i.e., lower competition) was associated with higher charges (in dollar) in both 2002 and 2010, while the magnitude became greater. The association between the HHI and LOS was statistically significant only in 2010, and it was positive. This indicates that lower competition (higher HHI) was associated with longer LOS for hospitals with more than 300 beds.

<Table 4> Multilevel mixed model: association of the HHI with LOS for patients without comorbidity in 2002 and 2010

	2002				2010			
	Null	model 1	model 2	model 3	Null	model 1	model 2	model 3
Intercept	2.9***	2.4***		3.7*	2.7***	1.8***	0.2141	−0.4
Patient-level								
Gender								
Male								
Female		−0.6***		−0.6***		−0.6***		−0.6***
Age								
Less than 40								
40∼64		−0.3***		−0.3***		0.04		0.03
65 and more		−1.0***		−010***		−0.4***		−0.4***
Income								
Medical aid								
20% and less		1.2***		1.2***		1.1*		1.1**
21∼40%		0.8*		0.9**		2.2***		2.3***
41∼60%		1.6***		1.7***		1.3**		1.2**
61∼80%		0.8*		0.9**		1.0*		1.1*
81% and more		0.8***		1.0**		1.1*		1.1*
Procedure								
Nonsurgery								
Surgery		10.1***		10.2***		9.9**		9.6**
Hospital-level								
Hospital classification								
Teaching hospital or general hospital								
Small hospital			1.1	1.1			0.5	0.5
Ownership status								
Public								
Private			−4.7***	−4.4***			1.3*	1.1
Number of beds								
30∼300								
301∼500			−0.6	−0.6			0.3	0.3
501∼1000			−1.2	−1.3			−0.1	−0.1
1001∼1500			−1.4	−1.6			0.5	0.5
1500 and more			−2.0	−2.3			2.0	2.2
Number of doctors			0.6**	0.7**			−0.03	−0.02
CT								
No								
Yes			−0.2	−0.3			0.3	0.2
MRI								
No								
Yes			−0.9	−0.9			−0.3	−0.3
HHI (by 100 points)			0.3***	0.3***			0.8***	0.9***

<Table 4> (continued)

	2002				2010			
	Null	model 1	model 2	model 3	Null	model 1	model 2	model 3
Number of beds in clinic (per 1000 persons)								
Low			0.6**	0.5*			−0.03	−0.02
Middle			1.0***	1.0***			−0.1	−0.1
High								
Number of doctors (per 1000 persons)								
Low			0.8***	0.9***			0.9***	0.9***
Middle			1.0***	1.0***			0.1	0.1
High								
Error variance								
Hospital-level	6.7836***	6.5383***	6.129***	5.9175***	6.8108***	6.7506***	6.8838***	6.8484***
Residual	8.2154***	7.9793***	8.1155***	7.8805***	11.5235***	11.2835***	11.4891***	11.2452***
ICC	0.45227	0.450371	0.430271	0.428867	0.371479	0.374324	0.374671	0.378498
Model fit								
−2 Res Log Likelihood	102934	102329.9	102660.4	102052.1	378277.2	376788.6	378074.7	376560.3
AIC	102940	102353.9	102694.4	102104.1	378283.2	376812.6	378108.7	376612.3

*** p<0.001, ** p<0.01, * p<0.05

Model 1=only adjusted patient-level, model 2=only adjusted hospital-level, and model 3=fully adjusted.

<Table 5> Multilevel mixed model: the association of the HHI with chargesa and LOS according to bed size in 2002 and 2010

	Charge		LOS	
	2002	2010	2002	2010
HHI(by 100 points) hospitals with 300 beds or less	−66.98 ***	114.33 ***	0.3786****	−0.4308***
HHI(by 100 points) hospitals with more than 300	15.19 ***	536.24 ***	−0.0438	2.3018 ***

※Adjusted for both individual and hospital-level variables

aUnit: US dollar. Costs converted from Korean won to US dollars according to annual average exchange rate

Ⅳ. DISCUSSION

This paper examined the influence of hospital competition on charges and LOS for DLSD. Charges and LOS are considered an indicator of hospital efficiency [16]. Our finding that increased hospital competition is related to lower charges and shorter LOS is similar to that of previous studies [22, 23]. the results of this study indicate that the magnitude of the effects of market competition on charges and LOS increased between 2002 and 2010 (charges: 57.5 dollars per HHI 100 points in 2002 and 353.7 dollars per HHI 100 points in 2010; LOS: 0.3 days per HHI 100 points in 2002 and 0.9 days per HHI 100 points in 2010). These findings were conceptualized using the S-C-P framework.

The results of this study also indicate that overall, the magnitudes of the association of market competition with charges and LOS became larger in 2010, compared to 2002. As the number of hospitals in Korea increases, it is not surprising that market competition becomes intense, which

also may have greater influence on hospital performance. However, this trend appears to happen slightly differently for hospitals with different size. In particular, for hospitals with 300 beds or less, increasing competition seems to be associated with lower charges, but higher LOS more lately. This may suggest that somewhat mixed behavior (e.g., lowering charges but increasing LOS) happens for smaller hospitals facing increased market competition. By contrast, for hospitals with more than 300 beds, higher market competition was associated with both reduced charges and LOS. These two different results may suggest that hospitals with different capacity appear to react differently to changes in market competition.

During the study period, efforts were made to reduce the average LOS. 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 [7]. Patients are not disturbed to enter directly to higher level services not experiencing the primary care level services in the first place, for there is no gate keeping system in Korea. Furthermore, the fee-for-service payment system may promote inefficiency that patients shop around among doctors and self-refer to a specialist [38]. In addition, since the mid-2000s, reducing out-of-pocket money by enhancing the benefit coverage for national health insurance has affected the increased access, the distortion of health care delivery and the centralization of patients to large hospitals even if patients with common health problems [39]. The concentration of patients in large hospitals led to a decrease in LOS in large hospitals. These changes might have affected the association of the HHI with charges and LOS for hospitals with more than 300 beds. Although increased competition might have resulted in a lower price per discharge, hospitals might have offset the lower prices through increased volume which would lead to higher total spending.

This study has several limitations. First, we performed a two-point cross sectional study, which made us a little difficult to make a causal relationship such as "changes in HHI lead to changes in costs and LOS". This issue could have been addressed with the current data using a panel model. However, we were not able to obtain the necessary data for the entire study period. Second, as only patients with DLSD were included in this study, the actual hospital market competition might be either under- or over-estimated. Third, because diagnosis codes higher than four digits were inaccurate, assigning an adjustment weight to comorbidity level was impossible. Thus, this study used an indicator for whether comorbidity existed as its severity adjustment. Future studies may use the Charlson Comorbidity Index (CCI) instead. Fourth, hospital financial statements were not included in the data, which may have influenced the outcome variables of this study. Fifth, our definition of the hospital market may be another significant limitation. Because 10 health service areas are the only official classification of hospital markets, this study used these areas to define hospital markets and to adjust regional-level variables; however, using these health service areas may have weakened our findings. Sixth, the data used in this study had no information about technologies available in the different geographical areas which may reflect the market structure. 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. Future

works may apply the more refined approach of hospital bed occupancy rate.

Despite these limitations, this is an important empirical study having several strengths. First, we used nationwide representative sample on health insurance claims, including socioeconomic data, medical care history, and medical care institution for about 1 million people. Using this representative national sample ensured high external validity. To our knowledge, this is the first study on efficiency of hospital market competition using such data for Korea. Thus, we could represent the effects of hospital market competition in Korea and compare these with that for other countries.

Second, this study is among the few that investigate long-term changes in competition to analyze hospitals' competitive behavior. When observing changes in market competition, a long study period is required.

Third, we adjusted individual-level, hospital-level, and market-level factors. Since market structure affects provider behaviors and ultimately performance, this study used the S-C-P framework and those factors. The results of this study found that market competition was indeed endogenous rather than exogenous. We could have constructed a regression model that addresses the endogeneity issue by using, for example, a two-stage least-squares (2SLS) with instrumental variables. However, the difficulty of finding appropriate instrumental variables and the cross-sectional design did not allow us to tackle the issue. We hope this limitation can be overcome in the future.

Lastly, this study provides useful information for policy makers to improve efficiency. Since the effect of market competition among large and small hospitals might work differently, implementation of different types of policy may be required, depending on the size of hospital.

Ⅴ. CONCLUSION

This study showed that hospital market structure (e.g., hospital competition) affects hospital efficiency (i.e., hospital charges and LOS). However, improved efficiency through market competition appears to be working differently for hospitals with different capacity. It is necessary to continue to monitor how changing market structure influences hospital outcomes, including more detailed outcomes such as patient satisfaction.

List of abbreviations: DLSD, degenerative lumbar spine disease; LOS, length of stay; OECD, Organization for Economic Co-operation and Development; DRGs, diagnosis-related groups; NHIS, National Health Insurance System; FFS, fee-for-service; MOHW, Ministry of Health and Welfare; S-C-P, structure-conduct-performance; KIHASA, Korea Institute for Health and Social Affairs; HHI, Herfindahl-Hirshman Index; KOSTAT, Korea National Statistical Office; ICC, intra-class correlation coefficient; AIC, CCI, Charlson Comorbidity Index; 2SLS, two-stage least-squares.

Acknowledgements: JEL designed the study, carried out the statistical analysis, and wrote the paper. E-CP and SGL provided important comments for the method and discussion. THK directed this study as corresponding author.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests: None declared.

Ethics approval: IRB of Graduate School of Public Health in Yonsei University.

Date sharing statement: We used public and national open data. It is available on ' http://www.nhis.or.kr', 'http://kostat.go.kr', and ' https://www.kihasa.re.kr'

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〈Abstract〉

Does Market Competition Reduce Hospital Charges & LOS for the Degenerative Lumbar Spinal Disease?: A Two-point Cross Sectional Study

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Background: Health care utilizations and costs of the patients with degenerative lumbar spine disease in Korea increased dramatically. We analyzed whether hospital market competition is associated with charges and length of stay for patients with degenerative lumbar spine disease.

Methods: We used Medical claims data of 2002 and 2010 from the nationwide representative sample of National Health Insurance Service of Korea. The study subjects were inpatients with degenerative lumbar spine disease (N=24,768) in 2002 and 2010. We employed a multilevel linear mixed model that included patient- and hospital-level variables in hierarchical data.

Results: Higher hospital competition was associated with lower charges (β =57.5, p<.0001 in 2002; β =353.7, p<.0001 in 2010) and shorter length of stay (β =0.3, p<.0001 in 2002; β =0.9, p<.0001 in 2010) in both 2002 and 2010. Compared to 2002, the magnitude of such association became greater in 2010. However, subgroup analyses show that the influence of competition on charges and length of stay differed by hospital size.

Conclusions: This study showed that hospital market structure (e.g., hospital competition) affects hospital efficiency (i.e., hospital charges and length of stay). It is necessary to continue to monitor how changing market structure influences hospital outcomes, including more detailed outcomes such as patient satisfaction.

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