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Governmental Designation of Spine Specialty Hospitals: Their characteristics, performance, and designation effects

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ABSTACT

Objectives: This study compares the characteristics and performance of spine specialty hospitals vs. other types of hospitals for inpatients with spinal diseases in South Korea. We also assessed the effect of the government's specialty hospital designation on hospital operating efficiency.

Setting: We used data of 823 hospitals including 17 spine specialty hospitals in Korea.

Participants: All spine disease-related inpatient claims nationwide (N=645,449) during 2010–2012.

Interventions: No interventions were made.

Outcome measures: Using a multi-level generalized estimating equation and multi-level modeling, this study compared inpatient charges, length of stay, readmission within 30 days of discharge, and in-hospital death within 30 days of admission in spine specialty versus other types of hospitals.

Results: Spine specialty hospitals had higher inpatient charges per day (27.4%) and a shorter length of stay (23.5%), but per case charges were similar, after adjusting for patient- and hospital-level confounders. After government designation, spine specialty hospitals had 8.6% lower per case charges, which was derived by reduced per day charge (7.6%) and shorter LOS (1.0%). Rates of readmission also were lower in spine specialty hospitals (odds ratio=0.796). Both patient- and hospital-level factors played important roles in determining outcome measures.

Conclusions: Spine specialty hospitals had higher per day inpatient charges but a much shorter LOS than other types of hospitals due to their specialty volume and experience. In addition, their readmission rate was lower. Spine specialty hospitals also endeavored to be more efficient after governmental "specialty" designation.

Strengths and limitations of this study

- This study is one of only a few studies to evaluate the performance and characteristics of specialty hospitals in this country where government designated the hospitals and even outside United States.
- This study used nationwide all spine related inpatient claims which accounted for 645,449 participants.
- This study provides reasoning for designing "specialty" designation requirements and implementing specialty hospital systems in health policy perspective
- The limitations of this study include lack of important patient's SES data and investigation of short-term policy effect.

Introduction

Since November 1, 2011 the Ministry of Health-Welfare Korea has designated 92 hospitals in South Korea as "specialty hospitals" to promote specialized, high quality care. These specialty hospitals encompass specialty areas including spine, joint, colorectal-anal, burn, breast, heart, ENT, ophthalmology, alcohol treatment, OBGYN, neurosurgery, and physical rehabilitation, etc. The highest number of hospitals with this designation (17) includes the spine specialty hospitals.

Since South Korea established a national health insurance (NHI) program in 1989, hospitals have faced many challenges such as an ageing population, rapidly rising healthcare costs, and growing chronic disease burden.[1] These challenges are being addressed by various policy initiatives at the government level. In addition, physicians' altering the mix of treatments to increase profit margin,[2] the increased level of competition among providers, provide incentives for increasing efficiency.[3] Moreover, providers have experienced financial challenges,[3] due in part to the rapid increase in small-general hospitals, from 581 in 2000 to 1,295 in 2010.[4] In order to address these challenges, small hospitals have begun to specialize in order to better compete with small general, mid-sized general, and even tertiary research hospitals.[5]

To be designated as a specialty hospital by the Korean Ministry of Health-Welfare, institutions must submit an application and be equipped with a certain number of beds, number of physicians, and have medical service departments in their specialty area. The inpatient volume of these institutions must be above the 30th percentile among all small and mid-sized general hospitals, and the ratio of specialty-area inpatients to total inpatients must be above a certain percentage depending upon the specialty area.

The concept of specialty hospitals was first introduced in the United States beginning in the 1990s. The first specialty hospitals typically were located in fast-growing cities in states where a "certificate of need" was not required.[6] Subsequently, there was a rapid increase in the number of small hospitals specializing in cardiac, orthopedic, and surgical services.[7] Furthermore, most of these hospitals were physician-owned, for-profit, and specialty-specific.[8]

Proponents argue that specialty hospitals provide high quality medical services at a lower cost,[9-11] bring added value to the healthcare system,[12,13] and lead to greater patient satisfaction.[14,15] The increase in patient volume and concentration of expertise allows specialty hospitals to achieve better outcomes and maximize efficiency.[16] On the other hand, opponents contend that specialty hospitals have lower quality and higher costs, since they are for-profit and specialize in only the most profitable services, target healthier patients who are more well-off, and induce demand for their specialized services.[17-20]

The purpose of this study was to compare the performance of spine specialty hospitals versus other types of hospitals in South Korea where in contrast to the physician-owned specialty hospitals in the United States, the South Korean government designates only qualified institutions as specialty hospitals, by evaluating the inpatient charge per case, inpatient charge per day, length of stay (LOS), readmission within 30 days of discharge, and in-hospital deaths within 30 days of admission for patients. In addition, this study also investigated the effect of designation as a “specialty” hospital on hospital operating efficiency.

Data and Methods

Database and Data Collection

In order to investigate the designation effect of specialty hospitals and to measure their performance, we collected all nationwide claims for inpatients diagnosed with spine diseases from categories used to determine the spine specialty hospital designation by the Ministry of Health and Welfare. Treatments for spine-related diseases included surgical procedures (discectomy, excision of intraspinal lesion, spinal fusion with deformity, spinal fusion, amputation, radical excision of malignant bone tumor, osteotomy and external fixation of extremity, etc.) and medical procedures specific to spinal disorders and injuries, osteomyelitis, connective tissue malignancy, connective tissue disorders, other musculoskeletal disorders, etc. We were able to access claims reported during the 7 months after the government began to designate specialty hospitals on November 1, 2011 (November.01.2011–May.31.2012) and included claims reported in the same 7-month period 1 year prior (November.01.2010–May.31.2011). Among nearly 1,600 hospitals

included in the database, only those that admitted more than one spinal-related inpatient case were included. Our analysis encompassed 645,449 patients hospitalized for spine-related illnesses nationwide during the study period, and 823 hospitals including 17 spine specialty hospitals.

Outcome Measures

Inpatient charges per case are the sum of Fee-For-Services (FFS) claims for each patient's hospitalization. LOS is measured as the number of inpatient days during each episode of hospitalization. We also calculated inpatient charge per day by dividing inpatient charges per case by the LOS. In Korea, the FFS schedule is negotiated by the government, medical providers, and other stakeholders every year. In 2012, the FFS catalogue increased by 1.9%, but there were no increases in 2010 and 2011. Hence, we discounted 2012 inpatient charges to 2010–2011 levels. The average foreign exchange rate in 2011 was 1 USD = 1108.09 KRW. Using the claim sample, we also calculated readmission within 30 days of discharge and mortality within 30 days of admission date as a binary variable if a patient was re-hospitalized soon after discharge or died during hospitalization.

Covariates

This dataset contained inpatient claim details, including patient ID, disease diagnosed, admission/discharge date, sex, age, complexity of illness, and the hospital to which each patient was admitted. Complexity of illness was measured by the provider and reported as claim data using the complication or comorbidity level [CCL 0=patient does not have a complication or comorbidity (CC), 1=patient has a minor CC, 2=patient has a moderate CC, 3=patient has a complex CC)] when each patient was admitted. Patient claims data were matched to the hospitals where each patient was admitted.

Hospital-level data included characteristics of the hospital, such as hospital type (specialty, tertiary, large, small), number of beds (in 100 bed increments), specialists per 100 beds, nurses per 100 beds, hospital location (metropolitan if located in cities with a population of more than one million), teaching status, and bed occupancy rate. According to the Korean Hospital Association (KHA), Korean hospitals are categorized into three

categories based on bed size: 1) hospitals with over 1,000 beds: tertiary research university hospitals, 2) hospitals with 300–1,000 beds: mid-sized general hospitals, and 3) hospitals with 100–300 beds: small general hospitals. Both the specialty hospitals and the small general hospitals in our study fell within category 3 (small-general hospitals) [21].

We also included data envelopment analysis (DEA) using efficiency as the dummy variable (1=efficient, 0=non-efficient) to determine whether hospitals were operated efficiently using a conventional technical efficiency measuring technique [22]. Input variables included number of beds, surgical beds, recovery beds, specialists, residents, nurses, physical therapists, pharmacists, and PET, CT, and MRI units of each hospital. Output variables included total number of inpatient cases and sum of charges in both 2011 and 2012 study periods for each hospital. Hospital-level statistics were collected based on their first quarter of 2012 status, which was the only available dataset at the time of this study.

Analytical Approach

Mean and standard deviation were analyzed for continuous variables, frequency and percent were analyzed for categorical variables. Univariate analysis of inpatient charges, LOS, readmission within 30 days of discharge, and mortality within 30 days of admission was performed to investigate the unadjusted effects of hospital types on these measures. Analysis of variance and chi-square tests were performed for identification of group differences. Because the unit of analysis was each patient's hospitalization, this study utilized multi-level generalized estimating equation regression (GEE) models in order to avoid problems created by possible nesting of patient observations in hospitals and overestimation of significance.

The GEE regression models were used to investigate the performance and characteristics of specialty hospitals, including the inpatient charges, LOS, readmission, and mortality adjusting for patient- and hospital-level confounders. Because the distributions of continuous dependent variables (inpatient charges & LOS) were skewed, we utilized log transformation in order to improve the distribution characteristics of the data. In addition, we ran the GEEs of the binary outcome variables for readmission within 30 days of discharge and mortality within 30 days of admission. SAS 9.2 (SAS institute, Cary, NC) was used for all calculations and analyses. The dataset does not have patient identification information, no ethics committee approval is required.

Results

[Inset Table 1 Here]

A total of 645,449 patients nationwide were hospitalized for spinal disease during the study periods, and 17 specialty hospitals accounted for 45,649 (7.1%) patients nationwide admitted for spine disease. Patients in spine specialty hospitals were more likely to be aged and female, to have had more surgical procedures, and have lower CCL scores. The increase in volume in 2012 compared to 2011 was greater than average in specialty hospitals as well as in conventional hospitals (total : 12.9% vs. specialty 17.8%).

[Inset Table 2 Here]

Table 2 shows the hospital characteristics analyzed. Of the 823 hospitals in our study, there were 17 Ministry of Health and Welfare-designated spine specialty hospitals (2.1% of the total), which accounted for 7.1% of the total spinal procedures performed nationwide during the study period. While none of these was a teaching hospital, they were located mainly in metropolitan areas, and their structural factors were greater in terms of number of 100 beds, specialists per 100 beds, and nurses per 100 beds as well as bed occupancy rate as compared to hospitals in the small-general hospital category. Although specialty hospitals are larger than small-general hospitals in terms of structural factors, both types of hospitals fall within the same small hospital category in Korea. Clinical staffs were larger in spine specialty hospitals than in mid-sized general hospitals. Furthermore, 11.8% of specialty hospitals were considered to be efficient compared with 6.8% of all hospitals.

[Inset Table 3 Here]

Univariate analysis of outcome variables (see Table 3) revealed that inpatient charges per case were lowest in spine specialty hospitals; however, per day charges were larger than small and mid-sized general hospitals. LOS was 10.9 days per admission, which was comparable to tertiary research hospitals, but was much shorter than small and mid-sized general hospitals. Readmission within 30 days of discharge was much lower for the spine specialty hospitals than other hospital types. Death within 30 days of admission also was lowest in specialty hospitals; however, the case was very rare in all types of hospitals because spinal procedures typically are not based on life-threatening conditions. Lower charges per case, charges per day, and reduced LOS were observed among specialty hospitals during the post-designation period.

[Inset Table 4 Here]

The results of our multi-level GEE regression analysis are presented in Table 4. Although spine specialty hospitals had a 2.8% higher inpatient charge per case than small-general hospitals, the difference was not statistically significant. An effect of the official "specialty" designation was found with regard to inpatient charge per case, with charges per case decreasing 8.6% after specialty status was conferred. Spine specialty hospitals charged an average of 27.4% more than small-general hospitals on a per-day basis, although the LOS at spine specialty hospitals was 23.5% shorter. Moreover, charges per case decreased 7.6% and LOS was reduced by 1.0% after specialty status was conferred. The odds of readmission were Odds Ratio (OR)=0.796 for the spine specialty hospitals compared to small-general hospitals; however, the odds of mortality were not statistically significant. This "designation effect" was not noted for either readmission or mortality outcomes. Efficient hospitals were more likely to follow the trend of spine specialty hospitals in terms of charging and LOS. Males were associated with higher charges per case and per day, but shorter LOS. Patients with higher CCL scores had greater charges per case and longer LOS. Hospitals located in metropolitan areas had higher charges per case and shorter LOS. Teaching hospitals had higher charges per case but no significant difference in charge per day or LOS when compared to non-teaching hospitals. Hospital structural factors also were associated with outcome variables; however, the effects were minimal.

Discussion

In this study, we investigated the performance and efficiency of spine specialty hospitals versus general hospitals and examined the effect of “specialty” hospital designation on hospital operating efficiency. Our dataset included spine specialty hospital designation criteria, and nationwide inpatient claims in South Korea. Our univariate results showed that charges per inpatient case were lower and LOS were much shorter for specialty hospitals; however, per day charges were higher than other hospitals with the exception of tertiary hospitals. The results of multivariate analysis, after adjusting for patient- and hospital-level confounders, showed that while spine specialty hospital charges on a per case basis were similar to those of small-general hospitals, the per day charges were 27.4% higher; however, the higher per day charges was balanced by 23.5% shorter LOS. Following “specialty” hospital designation, inpatient charges per case declined by 8.6%, because of shorter LOS (1.0%) and lower per day charges (7.6%) than general hospitals of comparable size.

Although this study considered only short-term effects of the “specialty” designation, spine specialty hospitals appeared to be motivated to reduce their charges. This effect suggests that spine specialty hospitals increased their efficiencies because of their spine specialization and resulting positive volume outcome relationship.[22,23] Therefore, these hospitals were able to reduce overall costs and charge less than other hospitals. This finding also indicates that the “specialty hospital” designation influenced spine specialty hospitals to reduce the financial burden on their patients.

Our findings also revealed that specialty hospitals had much shorter LOS for each spine inpatient. This result supports the premise that specialty hospital physicians have more experience due to their sheer volume, which also allows the specialty hospital to emphasize efficiency by reducing LOS. Shorter LOS for the specialty hospitals was superior to small, mid-sized general hospitals and also was better than tertiary hospitals. However, higher per day charges indicated that specialty hospitals ensure financially viability via high volume and bed turnover. In order to be designated a specialty hospital in Korea, an institution must meet strict institutional requirements, including having a certain number of beds and physicians in addition to operating a specialty medical service department. This process requires a substantial investment by the institution. Since no additional reimbursements or financial subsidies for specialty hospitals exist, might be only marketing effect, institutions ensure financial viability by increasing their efficiency.

Furthermore, specialty hospitals are most commonly located in metropolitan areas and therefore incur high rent, payroll, and other operating costs. Therefore, the overall operating costs for specialty hospitals are often higher than those for hospitals that are located in non-metropolitan areas.[24] This demographic would suggest that specialty hospitals offset their high operating costs by charging more per day for a shorter LOS, thus increasing patient volume and bed turnover. DEA results also indicated that in order for hospitals to achieve operational efficiency, they might have shorter LOS (24.1%) and higher charge per day (22.8%) than non-efficient hospitals, although charge per case is similar. This finding supports the trend observed for higher specialty hospital efficiency with regard to patient charges and LOS.

Comparing quality measures between specialty hospitals and small-general hospitals of similar size, readmission within 30 days of discharge was 20% lower (OR=0.796) in spine specialty hospitals but was similar to larger hospitals (mid-sized, tertiary hospitals). This quality measure might be better in spine specialty hospitals because of their higher patient volume and much stronger medical experience in the area of spine disease. However, we did not find any association with mortality within 30 days of admission to spine specialty hospitals. We would expect very few cases of mortality among all types of hospitals since spine disease procedures typically are not life-threatening. Of note, our study was only able to evaluate in-hospital mortality, which might underestimate actual mortality cases.

This study has several limitations worth considering; therefore, the results must be interpreted with caution. The potential limitation of our study involves our measurement of the effect of "specialty" designation status. Because of the relatively recent establishment of the specialty hospital designation system (11.01.2011), there has not been sufficient time to thoroughly investigate the effects of the "specialty" designation on hospital operating efficiency. Additional studies using more robust datasets should be performed to better inform long-term policy on spine specialty hospitals. In addition, we did not have access to information about non-NHI covered procedures, which is important because non-covered services are typical in spine-related procedures. Our study also lacked patient satisfaction records or socio-economic-status (SES) data that may have affected the results of our study.[25]

The other limitation was the inability to analyze hospital financial performance. Because we did not include institutions' financial statements or costs, it was not possible to examine the real financial viability of hospitals. Therefore, the actual revenue, costs, profit, and financial viability and their possible impact on our results remain unknown.

Although our study involved only spine-related inpatient claim data, it represents, to the best of our knowledge, one of only a few studies to evaluate the performance and characteristics of specialty hospitals in this country and outside United States as well. Our conclusions add to the mounting evidence about the greater efficiency and cost benefits of specialty hospitals; these results contribute to the reasoning for designing "specialty" designation requirements and implementing specialty hospital systems in health policy perspective. In order to strengthen the reliability and generalizability of our findings, additional studies investigating the effect of "specialty" designation status over a longer time frame are needed.

Conclusion

In conclusion, our study showed that spine specialty hospitals have higher per day inpatient charges and much shorter LOS than other types of hospitals due to their specialty volume and experience. Specialty hospitals endeavor to be more efficient after governmental "specialty" designation. In addition, the patient readmission rate was lower for specialty hospitals than general hospitals. To promote a successful specialty hospital system, a broader discussion that includes patient satisfaction and the real cost of care, should be initiated.

Financial Disclosure

The entire study was conducted without external funding.

Conflicts of Interests

None of the authors have any conflicts of interest associated with this study.

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S.J.K. designed the study, researched data, performed statistical analyses, and wrote the manuscript. S.G.L., T.H.K., J.W.Y. and E.C.P. contributed to the discussion and reviewed and edited the manuscript. E.C.P. is the guarantor of this work, and, as such, had full access to all data in the study and accepts responsibility for the integrity of the data and the accuracy of the data analysis. The manuscript is prepared with the manner of honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned.

Ethical approval

Not required.

Data sharing

No additional data available.

References

1. OECD. OECD Reviews of Health Care Quality: Korea 2012. OECD Publishing.
2. Kwon S. Payment system reform for health care providers in Korea. *Health Policy and Planning*. 2003;18:84-92.
3. Lee KS, Chun KH, Lee JS. Reforming the hospital service structure to improve efficiency: urban hospital specialization. *Health Policy*. 2008;87:41-49.
4. Ministry of Health and Wel-fare. http://stat.mw.go.kr [In Korean].
5. Kim J. Hospital performance and their foster plan. *Seoul. Korean Instiute of Hospital Management*. 2005.
6. Iglehart JK. The emergence of physician-owned specialty hospitals. *New England Journal of Medicine*. 2005;352:78-84.
7. Carey K, Burgess JF, Jr., Young GJ. Specialty and full-service hospitals: a comparative cost analysis. *Health Serv Res*. 2008;43:1869-1887.
8. Al-Amin M, Zinn J, Rosko MD, et al. Specialty hospital market proliferation: Strategic implications for general hospitals. *Health Care Management Review*. 2010;35:294-300.
9. Barro JR, Huckman RS, Kessler DP. The effects of cardiac specialty hospitals on the cost and quality of medical care. *Journal of health economics*. 2006;25:702-721.
10. Mitchell JM. Utilization changes following market entry by physician-owned specialty hospitals. *Medical Care Research and Review*. 2007;64:395-415.
11. Swartzmeyer S, Killoran C. Specialty hospital ban was premature. Studies would have shown whether those facilities help or harm healthcare. *Modern healthcare*. 2004;34:21.
12. Herzlinger R. “Specialty Hospitals, Ambulatory Surgery Centers, and General Hospitals: Charting a Wise Public Policy.” Conference held on September 10, Washington, DC. Waltham, MA: Council on Health Care Economics and Policy, 2004.
13. Porter ME, Teisberg EO. Redefining competition in health care. *Harv Bus Rev*. 2004;82:64-76, 136.
14. Casalino LP, Devers KJ, Brewster LR. Focused factories? Physician-owned specialty facilities. *Health Affairs*. 2003;22:56-67.
15. Medicare Payment Advisory Commission. Report to the Congress: physician-owned specialty hospitals. 2005.
16. United States General Accounting Office. Specialty Hospitals : Geographic Location, Services Provided, and Financial Peformance, Washington, DC. 2003.
17. Moore K, Coddington D. Specialty hospital rise could add to full-service hospital woes. *Healthcare financial management: journal of the Healthcare Financial Management Association*. 2005;59:84.
18. Nallamothu BK, Rogers MA, Chernew ME, et al. Opening of specialty cardiac hospitals and use of coronary revascularization in Medicare beneficiaries. *JAMA: the journal of the American Medical Association*. 2007;297:962-968.
19. Kahn CN, 3rd. Intolerable risk, irreparable harm: the legacy of physician-owned specialty hospitals. *Health Aff (Millwood)*. 2006;25:130-133.
20. American Hospital Association. Impact of limited-service providers on communities and full-service hospitals trendwatch. *trendwatch*. 2004;6(2):1-8.
21. Korean Hospital Association. Hospital Management Statistics. 2011.

22. Tsugawa Y, Kumamaru H, Yasunaga H, et al. The Association of Hospital Volume With Mortality and Costs of Care for Stroke in Japan. *Medical Care*. 2013;51:782-788.
23. Coté GA, Imler TD, Xu H, et al. Lower Provider Volume is Associated With Higher Failure Rates for Endoscopic Retrograde Cholangiopancreatography. *Medical Care*. 2013;51:1040-1047.
24. Kim SJ, Park EC, Jang SI, et al. An analysis of the inpatient charge and length of stay for patients with joint diseases in Korea: Specialty versus small general hospitals. *Health Policy*. 2013;113:93-99.
25. Perelman J, Closon MC. Impact of socioeconomic factors on in-patient length of stay and their consequences in per case hospital payment systems. *Journal of health services research & policy.* 2011;16(4):197-202.

Table 1. Characteristics of patients

	Total		Specialty Hospital		Tertiary Hospital		Mid-sized Hospital		Small Hospital		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Number of Cases	645,449		45,649	7.1	132,972	20.6	208,431	32.3	258,397	40.0	
Age*	52.6	19.7	55.8	15.5	47.3	23.0	53.5	20.5	54.1	17.1	<.0001
SEX											
Male	292,744	45.4	20,795	45.6	62,981	47.4	98,715	47.4	110,253	42.7	<.0001
Female	352,705	54.6	24,854	54.4	69,991	52.6	109,716	52.6	148,144	57.3	
Year											
Pre-Designation	303,220	47.0	20,956	45.9	64,173	48.3	100,647	48.3	117,444	45.5	<.0001
Post-Designation	342,229	53.0	24,693	54.1	68,799	51.7	107,784	51.7	140,953	54.5	
*** Volume increase in Post-Designation**	12.9%		17.8%		7.2%		7.1%		20.0%		
CCL Score											
0	436,621	67.6	32,190	70.5	93,631	70.4	124,595	59.8	186,205	72.1	<.0001
1	140,158	21.7	9,897	21.7	24,330	18.3	51,641	24.8	54,290	21.0	
2	56,346	8.7	3,114	6.8	11,974	9.0	25,939	12.4	15,319	5.9	
3	12,324	1.9	448	1.0	3,037	2.3	6,256	3.0	2,583	1.0	
Procedure Type											
Surgical	579,853	89.8	45,386	99.4	101,431	76.3	185,151	88.8	247,885	95.9	<.0001
Medical	65,596	10.2	263	0.6	31,541	23.7	23,280	11.2	10,512	4.1	

*** Mean/SD**

Table 2. Characteristics of hospitals

	Total		Specialty Hospital		Tertiary Hospital		Mid-sized Hospital		Small Hospital		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Number of Hospitals*	823		17	2.1	44	5.3	267	32.4	495	60.1	
Geographic											
Metropolitan area	439	53.3	14	82.4	33	75.0	129	48.3	263	53.1	0.001
Non-metropolitan area	384	46.7	3	17.6	11	25.0	138	51.7	232	46.9	
Teaching Status											
Teaching	149	18.1	-	0.0	44	100.0	102	38.2	3	0.6	<.0001
Non-Teaching	674	81.9	17	100.0	-	0.0	165	61.8	492	99.4	
DEA Efficiency											
Efficient	56	6.8	2	11.8	-	0.0	3	1.1	51	10.3	<.0001
Non-Efficient	767	93.2	15	88.2	44	100.0	264	98.9	444	89.7	
Number of 100 beds*	4.5	4.8	1.4	0.6	11.7	5.5	4.4	2.1	1.3	0.7	<.0001
Number of specialists per 100 beds*	14.7	8.1	15.7	5.6	25.9	7.1	13.7	5.4	9.5	4.0	<.0001
Number of nurses per 100 beds*	50.3	24.2	60.0	23.9	74.1	16.9	54.8	19.7	32.7	16.2	<.0001
Bed occupancy rate*	85.2	16.9	83.0	10.5	98.7	9.1	85.5	13.6	78.5	19.1	<.0001

*** Mean/SD**

Table 3. Univariate analysis of dependent variables by hospital types

	Specialty Hospital							Tertiary Hospital						
	Total		Pre-Designation		Post-Designation		P	Total		Pre-Designation		Post-Designation		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD		N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Charges per case [KRW]*	2,357,468	1,619,618	2,375,527	1,550,231	2,342,143	1,676,132	0.028	3,059,806	2,688,264	2,856,209	2,289,087	3,249,713	3,000,898	<.0001
Charges per day [KRW]*	251,661	150,845	252,214	164,000	251,191	138,707	0.471	323,255	231,344	311,785	223,778	333,953	237,687	<.0001
Length of Stay [Days]*	10.9	7.3	11.2	7.7	10.6	7.0	<.0001	10.6	9.2	10.7	9.4	10.5	9.1	<.0001
Readmission within 30 days of discharge														
Yes	505	1.11%	234	1.12%	271	1.10%	0.846	9,275	6.98%	4,408	6.87%	4,867	7.07%	0.142
No	45,144	98.89%	20,722	98.88%	24,422	98.90%		123,697	93.02%	59,765	93.13%	63,932	92.93%	
In-Hospital death within 30 days of admission														
Yes	1	0.00%	1	0.005%	-	0.0%	0.278	352	0.26%	172	0.27%	180	0.26%	0.821
No	45,648	100.00%	20,955	99.995%	24,693	100.0%		132,620	99.74%	64,001	99.73%	68,619	99.74%	

	Mid-sized Hospital							Small Hospital						
	Total		Pre-Designation		Post-Designation		P	Total		Pre-Designation		Post-Designation		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD		N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Charges per case [KRW]*	3,028,064	2,352,461	2,891,420	2,082,341	3,155,660	2,572,744	<.0001	2,559,995	2,170,122	2,479,704	2,050,050	2,626,895	2,263,145	<.0001
Charges per day [KRW]*	234,173	178,011	229,703	182,652	238,347	173,462	<.0001	246,804	180,053	245,242	190,559	248,106	170,796	<.0001
Length of Stay [Days]*	15.5	12.2	15.6	12.2	15.4	12.1	<.0001	12.5	9.3	12.6	9.5	12.4	9.2	<.0001
Readmission within 30 days of discharge														
Yes	5,761	2.76%	2,814	2.80%	2,947	2.73%	0.390	4,024	1.56%	1,880	1.60%	2,144	1.52%	0.103
No	202,670	97.24%	97,833	97.20%	104,837	97.27%		254,373	98.44%	115,564	98.40%	138,809	98.48%	
In-Hospital death within 30 days of admission														
Yes	432	0.21%	197	0.196%	235	0.2%	0.263	95	0.04%	38	0.03%	57	0.04%	0.286
No	207,999	99.79%	100,450	99.804%	107,549	99.8%		258,302	99.96%	117,406	99.97%	140,896	99.96%	

*** Mean/SD**

Table 4. Multi-level GEE analysis of inpatient charges per case, inpatient charges per day, length of stay, readmission, mortality.

	Ln_Charges per case		Ln_Charges per day		Ln_LOS		Readmission within 30 days of discharge		In-hospital death within 30days of admission	
	Est. [%]	P	Est. [%]	P	Est. [%]	P	Odds Ratio	P	Odds Ratio	P
Hospital Type										
Specialty hospital	0.028	0.605	0.274	<.0001	-0.235	<.0001	0.796	0.002	0.295	0.230
Tertiary hospital	0.313	<.0001	0.479	<.0001	-0.138	0.036	1.005	0.918	1.380	0.172
Mid-sized hospital	0.229	<.0001	0.175	<.0001	0.067	0.007	0.971	0.465	1.399	0.094
Small Hospital	Ref.									
Designation Effect										
Specialty hospital	-0.086	<.0001	-0.076	<.0001	-0.010	0.013	0.961	0.679	0.000	0.884
Tertiary hospital	0.024	<.0001	0.023	<.0001	0.001	0.827	1.062	0.148	0.720	0.168
Mid-sized hospital	0.001	0.836	0.004	0.241	-0.003	0.459	1.073	0.105	0.866	0.538
DEA Efficiency										
Efficient	-0.020	0.529	0.228	<.0001	-0.241	<.0001	0.977	0.508	0.556	0.064
Non-Efficient	Ref.									
Year										
2012	0.068	<.0001	0.072	<.0001	-0.004	0.143	0.987	0.699	1.250	0.292
2011	Ref.									
Age	0.002	<.0001	0.001	<.0001	0.001	<.0001	0.995	<.0001	1.030	<.0001
SEX										
Male	0.015	<.0001	0.040	<.0001	-0.025	<.0001	0.938	<.0001	1.245	0.002
Female	Ref.									
CCL Score										
1	0.181	<.0001	-0.038	<.0001	0.218	<.0001	1.127	<.0001	4.097	<.0001
2	0.314	<.0001	-0.001	0.574	0.315	<.0001	1.009	0.758	22.218	<.0001
3	0.533	<.0001	0.064	<.0001	0.469	<.0001	1.264	<.0001	185.824	<.0001
0	Ref.									
Geographic										
Metropolitan area	0.021	0.184	0.060	0.001	-0.038	0.054	0.994	0.792	0.948	0.521
Non-metropolitan area	Ref.									
Teaching Status										
Teaching	0.048	0.039	0.023	0.232	0.026	0.256	0.801	<.0001	1.072	0.567
Non-Teaching	Ref.									
Number of 100 beds	-0.007	0.125	-0.004	0.395	-0.004	0.460	1.014	<.0001	1.003	0.801
Number of specialists per 100 beds	-0.005	<.0001	0.004	<.0001	-0.009	<.0001	1.020	<.0001	1.004	0.609
Number of nurses per 100 beds	-0.001	<.0001	0.001	0.000	-0.003	<.0001	0.998	<.0001	1.004	0.099
Bed occupancy rate	0.002	<.0001	0.001	0.635	0.002	<.0001	1.000	0.672	0.998	0.483

As we described in the manuscript, this study used health insurance claim dataset. We do believe the STOBE checklist is most relevant form. Thank you.

	Item No	Recommendation	Page NO
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	In abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	In abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, explain how loss to follow-up was addressed	-
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	In table
		(b) Indicate number of participants with missing data for each variable of interest	In table
		(c) Summarise follow-up time (eg, average and total amount)	In table
Outcome data	15*	Report numbers of outcome events or summary measures over time	In table
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted	In table

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	In table
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10-11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

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Governmental Designation of Spine Specialty Hospitals, Their characteristics, performance, and designation effects: A Longitudinal Study in Korea

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ABSTACT

Objectives: This study compares the characteristics and performance of spine specialty hospitals vs. other types of hospitals for inpatients with spinal diseases in South Korea. We also assessed the effect of the government's specialty hospital designation on hospital operating efficiency.

Setting: We used data of 823 hospitals including 17 spine specialty hospitals in Korea.

Participants: All spine disease-related inpatient claims nationwide (N=645,449) during 2010–2012.

Interventions: No interventions were made.

Outcome measures: Using a multi-level generalized estimating equation and multi-level modeling, this study compared inpatient charges, length of stay, readmission within 30 days of discharge, and in-hospital death within 30 days of admission in spine specialty versus other types of hospitals.

Results: Spine specialty hospitals had higher inpatient charges per day (27.4%) and a shorter length of stay (23.5%), but per case charges were similar, after adjusting for patient- and hospital-level confounders. After government designation, spine specialty hospitals had 6.6% lower per case charges, which was derived by reduced per day charge (7.6%) and shorter LOS (1.0%). Rates of readmission also were lower in spine specialty hospitals (odds ratio=0.796). Both patient- and hospital-level factors played important roles in determining outcome measures.

Conclusions: Spine specialty hospitals had higher per day inpatient charges but a much shorter LOS than other types of hospitals due to their specialty volume and experience. In addition, their readmission rate was lower. Spine specialty hospitals also endeavored to be more efficient after governmental "specialty" designation.

Strengths and limitations of this study

- This study is one of only a few studies to evaluate the performance and characteristics of specialty hospitals in this country where government designated the hospitals and even outside United States.
- This study used nationwide all spine related inpatient claims which accounted for 645,449 participants.
- This study provides reasoning for designing "specialty" designation requirements and implementing specialty hospital systems in health policy perspective
- The limitations of this study include lack of important patient's SES data and investigation of short-term policy effect.

Introduction

Since November 1, 2011 the Ministry of Health-Welfare Korea has designated 92 hospitals in South Korea as "specialty hospitals" to promote specialized, high quality care. These specialty hospitals encompass specialty areas including spine, joint, colorectal-anal, burn, breast, heart, ENT, ophthalmology, alcohol treatment, OBGYN, neurosurgery, and physical rehabilitation, etc. The highest number of hospitals with this designation (17) includes the spine specialty hospitals.

Since South Korea established a national health insurance (NHI) program in 1989, hospitals have faced many challenges such as an ageing population, rapidly rising healthcare costs, and growing chronic disease burden.[1] These challenges are being addressed by various policy initiatives at the government level. In addition, physicians' altering the mix of treatments to increase profit margin,[2] the increased level of competition among providers, provide incentives for increasing efficiency.[3] Moreover, providers have experienced financial challenges,[3] due in part to the rapid increase in small-general hospitals, from 581 in 2000 to 1,295 in 2010.[4] In order to address these challenges, small hospitals have begun to specialize in order to better compete with small general, mid-sized general, and even tertiary research hospitals.[5]

To be designated as a specialty hospital by the Korean Ministry of Health-Welfare, institutions must submit an application and be equipped with a certain number of beds, number of physicians, and have medical service departments in their specialty area. The inpatient volume of these institutions must be above the 30th percentile among all small and mid-sized general hospitals, and the ratio of specialty-area inpatients to total inpatients must be above a certain percentage depending upon the specialty area.

The concept of specialty hospitals was first introduced in the United States beginning in the 1990s. The first specialty hospitals typically were located in fast-growing cities in states where a "certificate of need" was not required.[6] Subsequently, there was a rapid increase in the number of small hospitals specializing in cardiac, orthopedic, and surgical services.[7] Furthermore, most of these hospitals were physician-owned, for-profit, and specialty-specific.[8]

Proponents argue that specialty hospitals provide high quality medical services at a lower cost,[9-11] bring added value to the healthcare system,[12,13] and lead to greater patient satisfaction.[14,15] The increase in patient volume and concentration of expertise allows specialty hospitals to achieve better outcomes and maximize efficiency.[16] On the other hand, opponents contend that specialty hospitals have lower quality and higher costs, since they are for-profit and specialize in only the most profitable services, target healthier patients who are more well-off, and induce demand for their specialized services.[17-20]

The purpose of this study was to compare the performance of spine specialty hospitals versus other types of hospitals in South Korea where in contrast to the physician-owned specialty hospitals in the United States, the South Korean government designates only qualified institutions as specialty hospitals, by evaluating the inpatient charge per case, inpatient charge per day, length of stay (LOS), readmission within 30 days of discharge, and in-hospital deaths within 30 days of admission for patients. In addition, this study also investigated the effect of designation as a "specialty" hospital on hospital operating efficiency.

Data and Methods

Database and Data Collection

In order to investigate the designation effect of specialty hospitals and to measure their performance, we collected all nationwide claims for inpatients diagnosed with spine diseases from categories used to determine the spine specialty hospital designation by the Ministry of Health and Welfare. Treatments for spine-related diseases included surgical procedures (discectomy, excision of intraspinal lesion, spinal fusion with deformity, spinal fusion, amputation, radical excision of malignant bone tumor, osteotomy and external fixation of extremity, etc.) and medical procedures specific to spinal disorders and injuries, osteomyelitis, connective tissue malignancy, connective tissue disorders, other musculoskeletal disorders, etc. We were able to access claims reported during the 7 months after the government began to designate specialty hospitals on November 1, 2011 (November.01.2011–May.31.2012) and included claims reported in the same 7-month period 1 year prior (November.01.2010–May.31.2011). Among nearly 1,600 hospitals

included in the database, only those that admitted more than one spinal-related inpatient case were included. Our analysis encompassed 645,449 patients hospitalized for spine-related illnesses nationwide during the study period, and 823 hospitals including 17 spine specialty hospitals.

Outcome Measures

Inpatient charges per case are the sum of Fee-For-Services (FFS) claims for each patient's hospitalization. LOS is measured as the number of inpatient days during each episode of hospitalization. We also calculated inpatient charge per day by dividing inpatient charges per case by the LOS. In Korea, the FFS schedule is negotiated by the government, medical providers, and other stakeholders every year. In 2012, the FFS catalogue increased by 1.9%, but there were no increases in 2010 and 2011. Hence, we discounted 2012 inpatient charges to 2010–2011 levels. The average foreign exchange rate in 2011 was 1 USD = 1108.09 KRW. Using the claim sample, we also calculated readmission within 30 days of discharge and mortality within 30 days of admission date as a binary variable if a patient was re-hospitalized soon after discharge or died during hospitalization.

Covariates

This dataset contained inpatient claim details, including patient ID, disease diagnosed, admission/discharge date, sex, age, complexity of illness, and the hospital to which each patient was admitted. Complexity of illness was measured by the provider and reported as claim data using the complication or comorbidity level [CCL 0=patient does not have a complication or comorbidity (CC), 1=patient has a minor CC, 2=patient has a moderate CC, 3=patient has a complex CC)] when each patient was admitted. Patient claims data were matched to the hospitals where each patient was admitted.

Hospital-level data included characteristics of the hospital, such as hospital type (specialty, tertiary, large, small), number of beds (in 100 bed increments), specialists per 100 beds, nurses per 100 beds, hospital location (metropolitan if located in cities with a population of more than one million), teaching status, and bed occupancy rate. According to the Korean Hospital Association (KHA), Korean hospitals are categorized into three

categories based on bed size: 1) hospitals with over 1,000 beds: tertiary research university hospitals, 2) hospitals with 300–1,000 beds: mid-sized general hospitals, and 3) hospitals with 100–300 beds: small general hospitals. Both the specialty hospitals and the small general hospitals in our study fell within category 3 (small-general hospitals).[21] The hospital level data obtained from agency for Health Insurance Review & Assessment Services. In order to investigate post policy designation effect, we included interaction term of type of hospital and year which we named designation effect.

We also included data envelopment analysis (DEA) using efficiency as the dummy variable (1=efficient, 0=non-efficient) to determine whether hospitals were operated efficiently using a conventional technical efficiency measuring technique.[22] It is derived from microeconomics methodology that input and output combinations are depicted using a production function to measure multiple decision-making units' (DMUs, here hospitals) efficiency when the production process presents a structure of multiple inputs and outputs.[22] Input variables included number of beds, surgical beds, recovery beds, specialists, residents, nurses, physical therapists, pharmacists, and Positron Emission Tomography (PET), Computer Tomography (CT), and Magnetic Resonance Imaging (MRI) units of each hospital. Output variables included total number of inpatient cases and sum of charges in both 2011 and 2012 study periods for each hospital. Hospital-level statistics were collected based on their first quarter of 2012 status, which was the only available dataset at the time of this study.

Analytical Approach

Mean and standard deviation were analyzed for continuous variables, frequency and percent were analyzed for categorical variables. Univariate analysis of inpatient charges, LOS, readmission within 30 days of discharge, and mortality within 30 days of admission was performed to investigate the unadjusted effects of hospital types on these measures. Analysis of variance and chi-square tests were performed for identification of group differences. Because the unit of analysis was each patient's hospitalization, this study utilized multi-level generalized estimating equation regression (GEE) models in order to avoid problems created by possible nesting of patient observations in hospitals and overestimation of significance.

The GEE regression models were used to investigate the performance and characteristics of specialty hospitals, including the inpatient charges, LOS, readmission, and mortality adjusting for patient- and hospital-level confounders. Because the distributions of continuous dependent variables (inpatient charges & LOS) were skewed, we utilized log transformation in order to improve the distribution characteristics of the data. In addition, we ran the GEEs of the binary outcome variables for readmission within 30 days of discharge and mortality within 30 days of admission. In order to enhance case mix adjustment, we included the diagnosis and procedure code in the each model. SAS 9.2 (SAS institute, Cary, NC) was used for all calculations and analyses. The dataset does not have patient identification information, no ethics committee approval is required.

Results

[Inset Table 1 Here]

A total of 645,449 patients nationwide were hospitalized for spinal disease during the study periods, and 17 specialty hospitals accounted for 45,649 (7.1%) patients nationwide admitted for spine disease. Patients in spine specialty hospitals were aged and female, have had more surgical procedures, and have lower CCL scores. The increase in volume in 2012 compared to 2011 was greater than average in specialty hospitals as well as in conventional hospitals (total: 12.9% vs. specialty 17.8%).

[Inset Table 2 Here]

Table 2 shows the hospital characteristics analyzed. Of the 823 hospitals in our study, there were 17 Ministry of Health and Welfare-designated spine specialty hospitals (2.1% of the total), which accounted for 7.1% of the total spinal procedures performed nationwide during the study period. While none of these was a teaching hospital, they were located mainly in metropolitan areas, and their structural factors were greater in terms of number of 100 beds, specialists per 100 beds, and nurses per 100 beds as well as bed occupancy rate as compared to hospitals in the small-general hospital category. Although specialty hospitals are larger than small-general hospitals in terms of structural factors, both types of hospitals fall within the same small hospital category in Korea. Clinical staffs were larger in spine specialty hospitals than in mid-sized general hospitals. Furthermore, 11.8% of specialty hospitals were considered to be efficient compared with 6.8% of all hospitals.

[Inset Table 3 Here]

Univariate analysis of outcome variables (see Table 3) revealed that inpatient charges per case were lowest in spine specialty hospitals; however, per day charges were larger than small and mid-sized general hospitals. LOS was 10.9 days per admission, which was comparable to tertiary research hospitals, but was much shorter than small and mid-sized general hospitals. Readmission within 30 days of discharge was much lower for the spine specialty hospitals than other hospital types. Death within 30 days of admission also was lowest in specialty hospitals; however, the case was very rare in all types of hospitals because spinal procedures typically are not based on life-threatening conditions. Lower charges per case, charges per day, and reduced LOS were observed among specialty hospitals during the post-designation period.

[Inset Table 4 Here]

The results of our multi-level GEE regression analysis are presented in Table 4. Although spine specialty hospitals had a 2.8% higher inpatient charge per case than small-general hospitals, the difference was not statistically significant. An effect of the official "specialty" designation was found with regard to inpatient charge per case, with charges per case decreasing 6.6% after specialty status was conferred. Spine specialty hospitals charged an average of 27.4% more than small-general hospitals on a per-day basis, although the LOS at spine specialty hospitals was 23.5% shorter. Moreover, charges per case decreased 7.6% and LOS was reduced by 1.0% after specialty status was conferred. The odds of readmission were Odds Ratio (OR)=0.796 for the spine specialty hospitals compared to small-general hospitals; however, the odds of mortality were not statistically significant. This "designation effect" was not noted for either readmission or mortality outcomes. Efficient hospitals were more likely to follow the trend of spine specialty hospitals in terms of charging and LOS. Males were associated with higher charges per case and per day, but shorter LOS. Patients with higher CCL scores had greater charges per case and longer LOS. Hospitals located in metropolitan areas had higher charges per case and shorter LOS. Teaching hospitals had higher charges per case but no significant difference in charge per day or LOS when compared to non-teaching hospitals. Hospital structural factors also were associated with outcome variables; however, the effects were minimal.

Discussion

In this study, we investigated the performance and efficiency of spine specialty hospitals versus general hospitals and examined the effect of "specialty" hospital designation on hospital operating efficiency. Our dataset included spine specialty hospital designation criteria, and nationwide inpatient claims in South Korea. Our univariate results showed that charges per inpatient case were lower and LOS were much shorter for specialty hospitals; however, per day charges were higher than other hospitals with the exception of tertiary hospitals. The results of multivariate analysis, after adjusting for patient- and hospital-level confounders, showed that while spine specialty hospital charges on a per case basis were similar to those of small-general hospitals, the per day charges were 27.4% higher; however, the higher per day charges was balanced by 23.5% shorter LOS. Following "specialty" hospital designation, inpatient charges per case declined by 6.6%, because of shorter LOS (1.0%) and lower per day charges (7.6%) than general hospitals of comparable size.

Although this study considered only short-term effects of the "specialty" designation, spine specialty hospitals appeared to be motivated to reduce their charges. This effect suggests that spine specialty hospitals increased their efficiencies because of their spine specialization and resulting positive volume outcome relationship.[23,24] Therefore, these hospitals were able to reduce overall costs and charge less than other hospitals. This finding also indicates that the "specialty hospital" designation influenced spine specialty hospitals to reduce the financial burden on their patients.

Our findings also revealed that specialty hospitals had much shorter LOS for each spine inpatient. This result supports the premise that specialty hospital physicians have more experience due to their sheer volume, which also allows the specialty hospital to emphasize efficiency by reducing LOS. Shorter LOS for the specialty hospitals was superior to small, mid-sized general hospitals and also was better than tertiary hospitals. However, higher per day charges indicated that specialty hospitals ensure financially viability via high volume and bed turnover. In order to be designated a specialty hospital in Korea, an institution must meet strict institutional requirements, including having a certain number of beds and physicians in addition to operating a specialty medical service department. This process requires a substantial investment by the institution. Since no additional reimbursements or financial subsidies for specialty hospitals exist, might be only marketing effect, institutions ensure financial viability by increasing their efficiency. In addition, the results of our study also provide empirical research confirming the arguments of opponents of specialty hospitals that saying specialty hospitals may provide health care services at greater profit or cherry picking patients more than traditional hospitals.[6,17,18,20] Higher proportion of low CCL patients and surgery rate may support propositions of opponents.

Furthermore, specialty hospitals are most commonly located in metropolitan areas and therefore incur high rent, payroll, and other operating costs. Therefore, the overall operating costs for specialty hospitals are often higher than those for hospitals that are located in non-metropolitan areas.[25] This demographic would suggest that specialty hospitals offset their high operating costs by charging more per day for a shorter LOS, thus increasing patient volume and bed turnover. DEA results also indicated that in order for hospitals to achieve operational efficiency, they might have shorter LOS (24.1%) and higher charge per day (22.8%) than non-efficient hospitals, although charge per case is similar. This finding supports the trend observed for higher specialty hospital efficiency with regard to patient charges and LOS.

Comparing quality measures between specialty hospitals and small-general hospitals of similar size, readmission within 30 days of discharge was 20% lower (OR=0.796) in spine specialty hospitals but was similar to larger hospitals (mid-sized, tertiary hospitals). This quality measure might be better in spine specialty hospitals because of their higher patient volume and much stronger medical experience in the area of spine disease. However, we did not find any association with mortality within 30 days of admission to spine specialty hospitals. We would expect very few cases of mortality among all types of hospitals since spine disease procedures typically are not life-threatening. Of note, our study was only able to evaluate in-hospital mortality, which might underestimate actual mortality cases.

This study has several limitations worth considering; therefore, the results must be interpreted with caution. The potential limitation of our study involves our measurement of the effect of "specialty" designation status. Because of the relatively recent establishment of the specialty hospital designation system (11.01.2011), there has not been sufficient time to thoroughly investigate the effects of the "specialty" designation on hospital operating efficiency. Additional studies using more robust datasets should be performed to better inform long-term policy on spine specialty hospitals. Furthermore, this study may not fully adjust case-mix adjustment although the analysis models include current diagnosis and procedure code, due to the nature of claims data. In addition, we did not have access to information about non-NHI covered procedures, which is important because non-covered services are typical in spine-related procedures. Our study also lacked patient satisfaction records or socio-economic-status (SES) data that may have affected the results of our study.[26]

The other limitation was the inability to analyze hospital financial performance. Because we did not include institutions' financial statements or costs, it was not possible to examine the real financial viability of hospitals. Therefore, the actual revenue, costs, profit, and financial viability and their possible impact on our results remain unknown.

Although our study involved only spine-related inpatient claim data, it represents, to the best of our knowledge, one of only a few studies to evaluate the performance and characteristics of specialty hospitals in this country and outside United States as well. Our conclusions add to the mounting evidence about the greater efficiency and cost benefits of specialty hospitals; these results contribute to the reasoning for designing "specialty" designation requirements and implementing specialty hospital systems in health policy perspective. In order to strengthen the reliability and generalizability of our findings, additional studies investigating the effect of "specialty" designation status over a longer time frame are needed.

Conclusion

In conclusion, our study showed that spine specialty hospitals have higher per day inpatient charges and much shorter LOS than other types of hospitals due to their specialty volume and experience. Specialty hospitals endeavor to be more efficient after governmental "specialty" designation. In addition, the patient readmission rate was lower for specialty hospitals than general hospitals. To promote a successful specialty hospital system, a broader discussion that includes patient satisfaction and the real cost of care, should be initiated.

Financial Disclosure

The entire study was conducted without external funding.

Conflicts of Interests

None of the authors have any conflicts of interest associated with this study.

Author Contributions

S.J.K. designed the study, researched data, performed statistical analyses, and wrote the manuscript. J.W.Y., S.G.L., T.H.K., K.T.H. and E.C.P. contributed to the discussion and reviewed and edited the manuscript. E.C.P. is the guarantor of this work, and, as such, had full access to all data in the study and accepts responsibility for the integrity of the data and the accuracy of the data analysis. All authors fulfilled the authorship criteria given by the ICMJE guidelines.

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The manuscript is prepared with the manner of honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned.

Ethical approval

Not required.

Data sharing

No additional data available.

References

1. OECD. OECD Reviews of Health Care Quality: Korea 2012. OECD Publishing.
2. Kwon S. Payment system reform for health care providers in Korea. *Health Policy and Planning*. 2003;18:84-92.
3. Lee KS, Chun KH, Lee JS. Reforming the hospital service structure to improve efficiency: urban hospital specialization. *Health Policy*. 2008;87:41-49.
4. Ministry of Health and Wel-fare. http://stat.mw.go.kr [In Korean].
5. Kim J. Hospital performance and their foster plan. *Seoul. Korean Instiute of Hospital Management*. 2005.
6. Iglehart JK. The emergence of physician-owned specialty hospitals. *New England Journal of Medicine*. 2005;352:78-84.
7. Carey K, Burgess JF, Jr., Young GJ. Specialty and full-service hospitals: a comparative cost analysis. *Health Serv Res*. 2008;43:1869-1887.
8. Al-Amin M, Zinn J, Rosko MD, et al. Specialty hospital market proliferation: Strategic implications for general hospitals. *Health Care Management Review*. 2010;35:294-300.
9. Barro JR, Huckman RS, Kessler DP. The effects of cardiac specialty hospitals on the cost and quality of medical care. *Journal of health economics*. 2006;25:702-721.
10. Mitchell JM. Utilization changes following market entry by physician-owned specialty hospitals. *Medical Care Research and Review*. 2007;64:395-415.
11. Swartzmeyer S, Killoran C. Specialty hospital ban was premature. Studies would have shown whether those facilities help or harm healthcare. *Modern healthcare*. 2004;34:21.
12. Herzlinger R. "Specialty Hospitals, Ambulatory Surgery Centers, and General Hospitals: Charting a Wise Public Policy." Conference held on September 10, Washington, DC. Waltham, MA: Council on Health Care Economics and Policy, 2004.
13. Porter ME, Teisberg EO. Redefining competition in health care. *Harv Bus Rev*. 2004;82:64-76, 136.
14. Casalino LP, Devers KJ, Brewster LR. Focused factories? Physician-owned specialty facilities. *Health Affairs*. 2003;22:56-67.
15. Medicare Payment Advisory Commission. Report to the Congress: physician-owned specialty hospitals. 2005.
16. United States General Accounting Office. Specialty Hospitals : Geographic Location, Services Provided, and Financial Peformance, Washington, DC. 2003.
17. Moore K, Coddington D. Specialty hospital rise could add to full-service hospital woes. *Healthcare financial management: journal of the Healthcare Financial Management Association*. 2005;59:84.
18. Nallamothu BK, Rogers MA, Chernew ME, et al. Opening of specialty cardiac hospitals and use of coronary revascularization in Medicare beneficiaries. *JAMA: the journal of the American Medical Association*. 2007;297:962-968.
19. Kahn CN, 3rd. Intolerable risk, irreparable harm: the legacy of physician-owned specialty hospitals. *Health Aff (Millwood)*. 2006;25:130-133.
20. American Hospital Association. Impact of limited-service providers on communities and full-service hospitals trendwatch. *trendwatch*. 2004;6(2):1-8.
21. Korean Hospital Association. Hospital Management Statistics. 2011.

22. Charnes A, Clark CT, Cooper W, Golany B: A developmental study of data envelopment analysis in measuring the efficiency of maintenance units in the US air forces. *Annals of Operations Research* 1984;2(1):95-112.
23. Tsugawa Y, Kumamaru H, Yasunaga H, et al. The Association of Hospital Volume With Mortality and Costs of Care for Stroke in Japan. *Medical Care*. 2013;51:782-788.
24. Coté GA, Imler TD, Xu H, et al. Lower Provider Volume is Associated With Higher Failure Rates for Endoscopic Retrograde Cholangiopancreatography. *Medical Care*. 2013;51:1040-1047.
25. Kim SJ, Park EC, Jang SI, et al. An analysis of the inpatient charge and length of stay for patients with joint diseases in Korea: Specialty versus small general hospitals. *Health Policy*. 2013;113:93-99.
26. Perelman J, Closon MC. Impact of socioeconomic factors on in-patient length of stay and their consequences in per case hospital payment systems. *Journal of health services research & policy.* 2011;16(4):197-202.

Table 1. Characteristics of patients

	Total		Specialty Hospital		Tertiary Hospital		Mid-sized Hospital		Small Hospital		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Number of Cases	645,449		45,649	7.1	132,972	20.6	208,431	32.3	258,397	40.0	
Age*	52.6	19.7	55.8	15.5	47.3	23.0	53.5	20.5	54.1	17.1	<.0001
SEX											
Male	292,744	45.4	20,795	45.6	62,981	47.4	98,715	47.4	110,253	42.7	<.0001
Female	352,705	54.6	24,854	54.4	69,991	52.6	109,716	52.6	148,144	57.3	
Year											
Pre-Designation	303,220	47.0	20,956	45.9	64,173	48.3	100,647	48.3	117,444	45.5	<.0001
Post-Designation	342,229	53.0	24,693	54.1	68,799	51.7	107,784	51.7	140,953	54.5	
*** Volume increase in Post-Designation**	12.9%		17.8%		7.2%		7.1%		20.0%		
CCL Score											
0	436,621	67.6	32,190	70.5	93,631	70.4	124,595	59.8	186,205	72.1	<.0001
1	140,158	21.7	9,897	21.7	24,330	18.3	51,641	24.8	54,290	21.0	
2	56,346	8.7	3,114	6.8	11,974	9.0	25,939	12.4	15,319	5.9	
3	12,324	1.9	448	1.0	3,037	2.3	6,256	3.0	2,583	1.0	
Procedure Type											
Surgical	579,853	89.8	45,386	99.4	101,431	76.3	185,151	88.8	247,885	95.9	<.0001
Medical	65,596	10.2	263	0.6	31,541	23.7	23,280	11.2	10,512	4.1	

*** Mean/SD**

Table 2. Characteristics of hospitals

	Total		Specialty Hospital		Tertiary Hospital		Mid-sized Hospital		Small Hospital		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Number of Hospitals*	823		17	2.1	44	5.3	267	32.4	495	60.1	
Geographic											
Metropolitan area	439	53.3	14	82.4	33	75.0	129	48.3	263	53.1	0.001
Non-metropolitan area	384	46.7	3	17.6	11	25.0	138	51.7	232	46.9	
Teaching Status											
Teaching	149	18.1	-	0.0	44	100.0	102	38.2	3	0.6	<.0001
Non-Teaching	674	81.9	17	100.0	-	0.0	165	61.8	492	99.4	
DEA Efficiency											
Efficient	56	6.8	2	11.8	-	0.0	3	1.1	51	10.3	<.0001
Non-Efficient	767	93.2	15	88.2	44	100.0	264	98.9	444	89.7	
Number of 100 beds*	4.5	4.8	1.4	0.6	11.7	5.5	4.4	2.1	1.3	0.7	<.0001
Number of specialists per 100 beds*	14.7	8.1	15.7	5.6	25.9	7.1	13.7	5.4	9.5	4.0	<.0001
Number of nurses per 100 beds*	50.3	24.2	60.0	23.9	74.1	16.9	54.8	19.7	32.7	16.2	<.0001
Bed occupancy rate*	85.2	16.9	83.0	10.5	98.7	9.1	85.5	13.6	78.5	19.1	<.0001

*** Mean/SD**

Table 3. Univariate analysis of dependent variables by hospital types

	Specialty Hospital							Tertiary Hospital						
	Total		Pre-Designation		Post-Designation		P	Total		Pre-Designation		Post-Designation		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD		N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Charges per case [KRW]*	2,357,468	1,619,618	2,375,527	1,550,231	2,342,143	1,676,132	0.028	3,059,806	2,688,264	2,856,209	2,289,087	3,249,713	3,000,898	<.0001
Charges per day [KRW]*	251,661	150,845	252,214	164,000	251,191	138,707	0.471	323,255	231,344	311,785	223,778	333,953	237,687	<.0001
Length of Stay [Days]*	10.9	7.3	11.2	7.7	10.6	7.0	<.0001	10.6	9.2	10.7	9.4	10.5	9.1	<.0001
Readmission within 30 days of discharge														
Yes	505	1.11%	234	1.12%	271	1.10%	0.846	9,275	6.98%	4,408	6.87%	4,867	7.07%	0.142
No	45,144	98.89%	20,722	98.88%	24,422	98.90%		123,697	93.02%	59,765	93.13%	63,932	92.93%	
In-Hospital death within 30 days of admission														
Yes	1	0.00%	1	0.005%	-	0.0%	0.278	352	0.26%	172	0.27%	180	0.26%	0.821
No	45,648	100.00%	20,955	99.995%	24,693	100.0%		132,620	99.74%	64,001	99.73%	68,619	99.74%	

	Mid-sized Hospital							Small Hospital						
	Total		Pre-Designation		Post-Designation		P	Total		Pre-Designation		Post-Designation		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD		N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Charges per case [KRW]*	3,028,064	2,352,461	2,891,420	2,082,341	3,155,660	2,572,744	<.0001	2,559,995	2,170,122	2,479,704	2,050,050	2,626,895	2,263,145	<.0001
Charges per day [KRW]*	234,173	178,011	229,703	182,652	238,347	173,462	<.0001	246,804	180,053	245,242	190,559	248,106	170,796	<.0001
Length of Stay [Days]*	15.5	12.2	15.6	12.2	15.4	12.1	<.0001	12.5	9.3	12.6	9.5	12.4	9.2	<.0001
Readmission within 30 days of discharge														
Yes	5,761	2.76%	2,814	2.80%	2,947	2.73%	0.390	4,024	1.56%	1,880	1.60%	2,144	1.52%	0.103
No	202,670	97.24%	97,833	97.20%	104,837	97.27%		254,373	98.44%	115,564	98.40%	138,809	98.48%	
In-Hospital death within 30 days of admission														
Yes	432	0.21%	197	0.196%	235	0.2%	0.263	95	0.04%	38	0.03%	57	0.04%	0.286
No	207,999	99.79%	100,450	99.804%	107,549	99.8%		258,302	99.96%	117,406	99.97%	140,896	99.96%	

*** Mean/SD**

Table 4. Multi-level GEE analysis of inpatient charges per case, inpatient charges per day, length of stay, readmission, mortality.

			Ln_Charges per case		Ln_Charges per day		Ln_LOS		Readmission within 30 days of discharge		In-Hospital death within 30 days of admission	
			Est. [%]	P	Est. [%]	P	Est. [%]	P	Odds Ratio	P	Odds Ratio	P
Patient Level	Age		0.002	<.0001	0.001	<.0001	0.001	<.0001	0.995	<.0001	1.030	<.0001
	SEX											
		Male	0.015	<.0001	0.040	<.0001	-0.025	<.0001	0.938	<.0001	1.245	0.002
		Female	Ref.									
	CCL Score											
		1	0.181	<.0001	-0.038	<.0001	0.218	<.0001	1.127	<.0001	4.097	<.0001
		2	0.314	<.0001	-0.001	0.574	0.315	<.0001	1.009	0.758	22.218	<.0001
		3	0.533	<.0001	0.064	<.0001	0.469	<.0001	1.264	<.0001	185.824	<.0001
		0	Ref.									
	Year											
		2012	0.068	<.0001	0.072	<.0001	-0.004	0.143	0.987	0.699	1.250	0.292
		2011	Ref.									
Hospital Level	Hospital Type											
		Specialty hospital	0.028	0.605	0.274	<.0001	-0.235	<.0001	0.796	0.002	0.295	0.230
		Tertiary hospital	0.313	<.0001	0.479	<.0001	-0.138	0.036	1.005	0.918	1.380	0.172
		Mid-sized hospital	0.229	<.0001	0.175	<.0001	0.067	0.007	0.971	0.465	1.399	0.094
		Small Hospital	Ref.									
	Designation Effect											
		Specialty hospital	-0.066	<.0001	-0.076	<.0001	-0.010	0.013	0.961	0.679	0.000	0.884
		Tertiary hospital	0.024	<.0001	0.023	<.0001	0.001	0.827	1.062	0.148	0.720	0.168
		Mid-sized hospital	0.001	0.836	0.004	0.241	-0.003	0.459	1.073	0.105	0.866	0.538
	DEA Efficiency											
		Efficient	-0.020	0.529	0.228	<.0001	-0.241	<.0001	0.977	0.508	0.556	0.064
		Non-Efficient	Ref.									
	Geographic											
		Metropolitan area	0.021	0.184	0.060	0.001	-0.038	0.054	0.994	0.792	0.948	0.521
		Non-metropolitan area	Ref.									
	Teaching Status											
		Teaching	0.048	0.039	0.023	0.232	0.026	0.256	0.801	<.0001	1.072	0.567
		Non-Teaching	Ref.									
	Number of 100 beds		-0.007	0.125	-0.004	0.395	-0.004	0.460	1.014	<.0001	1.003	0.801
	Number of specialists per 100 beds		-0.005	<.0001	0.004	<.0001	-0.009	<.0001	1.020	<.0001	1.004	0.609
	Number of nurses per 100 beds		-0.001	<.0001	0.001	0.000	-0.003	<.0001	0.998	<.0001	1.004	0.099
	Bed occupancy rate		0.002	<.0001	0.001	0.635	0.002	<.0001	1.000	0.672	0.998	0.483

Note: Each model was adjusted by diagnosis and procedure codes

Governmental Designation of Spine Specialty Hospitals, Their characteristics, performance, and designation effects: A Longitudinal Study in Korea

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ABSTACT

Objectives: This study compares the characteristics and performance of spine specialty hospitals vs. other types of hospitals for inpatients with spinal diseases in South Korea. We also assessed the effect of the government's specialty hospital designation on hospital operating efficiency.

Setting: We used data of 823 hospitals including 17 spine specialty hospitals in Korea.

Participants: All spine disease-related inpatient claims nationwide (N=645,449) during 2010–2012.

Interventions: No interventions were made.

Outcome measures: Using a multi-level generalized estimating equation and multi-level modeling, this study compared inpatient charges, length of stay, readmission within 30 days of discharge, and in-hospital death within 30 days of admission in spine specialty versus other types of hospitals.

Results: Spine specialty hospitals had higher inpatient charges per day (27.4%) and a shorter length of stay (23.5%), but per case charges were similar, after adjusting for patient- and hospital-level confounders. After government designation, spine specialty hospitals had 6.6% lower per case charges, which was derived by reduced per day charge (7.6%) and shorter LOS (1.0%). Rates of readmission also were lower in spine specialty hospitals (odds ratio=0.796). Both patient- and hospital-level factors played important roles in determining outcome measures.

Conclusions: Spine specialty hospitals had higher per day inpatient charges but a much shorter LOS than other types of hospitals due to their specialty volume and experience. In addition, their readmission rate was lower. Spine specialty hospitals also endeavored to be more efficient after governmental "specialty" designation.

Strengths and limitations of this study

- This study is one of only a few studies to evaluate the performance and characteristics of specialty hospitals in this country where government designated the hospitals and even outside United States.
- This study used nationwide all spine related inpatient claims which accounted for 645,449 participants.
- This study provides reasoning for designing "specialty" designation requirements and implementing specialty hospital systems in health policy perspective
- The limitations of this study include lack of important patient's SES data and investigation of short-term policy effect.

Introduction

Since November 1, 2011 the Ministry of Health-Welfare Korea has designated 92 hospitals in South Korea as "specialty hospitals" to promote specialized, high quality care. These specialty hospitals encompass specialty areas including spine, joint, colorectal-anal, burn, breast, heart, ENT, ophthalmology, alcohol treatment, OBGYN, neurosurgery, and physical rehabilitation, etc. The highest number of hospitals with this designation (17) includes the spine specialty hospitals.

Since South Korea established a national health insurance (NHI) program in 1989, hospitals have faced many challenges such as an ageing population, rapidly rising healthcare costs, and growing chronic disease burden.[1] These challenges are being addressed by various policy initiatives at the government level. In addition, physicians' altering the mix of treatments to increase profit margin,[2] the increased level of competition among providers, provide incentives for increasing efficiency.[3] Moreover, providers have experienced financial challenges,[3] due in part to the rapid increase in small-general hospitals, from 581 in 2000 to 1,295 in 2010.[4] In order to address these challenges, small hospitals have begun to specialize in order to better compete with small general, mid-sized general, and even tertiary research hospitals.[5]

To be designated as a specialty hospital by the Korean Ministry of Health-Welfare, institutions must submit an application and be equipped with a certain number of beds, number of physicians, and have medical service departments in their specialty area. The inpatient volume of these institutions must be above the 30th percentile among all small and mid-sized general hospitals, and the ratio of specialty-area inpatients to total inpatients must be above a certain percentage depending upon the specialty area.

The concept of specialty hospitals was first introduced in the United States beginning in the 1990s. The first specialty hospitals typically were located in fast-growing cities in states where a "certificate of need" was not required.[6] Subsequently, there was a rapid increase in the number of small hospitals specializing in cardiac, orthopedic, and surgical services.[7] Furthermore, most of these hospitals were physician-owned, for-profit, and specialty-specific.[8]

Proponents argue that specialty hospitals provide high quality medical services at a lower cost,[9-11] bring added value to the healthcare system,[12,13] and lead to greater patient satisfaction.[14,15] The increase in patient volume and concentration of expertise allows specialty hospitals to achieve better outcomes and maximize efficiency.[16] On the other hand, opponents contend that specialty hospitals have lower quality and higher costs, since they are for-profit and specialize in only the most profitable services, target healthier patients who are more well-off, and induce demand for their specialized services.[17-20]

The purpose of this study was to compare the performance of spine specialty hospitals versus other types of hospitals in South Korea where in contrast to the physician-owned specialty hospitals in the United States, the South Korean government designates only qualified institutions as specialty hospitals, by evaluating the inpatient charge per case, inpatient charge per day, length of stay (LOS), readmission within 30 days of discharge, and in-hospital deaths within 30 days of admission for patients. In addition, this study also investigated the effect of designation as a "specialty" hospital on hospital operating efficiency.

Data and Methods

Database and Data Collection

In order to investigate the designation effect of specialty hospitals and to measure their performance, we collected all nationwide claims for inpatients diagnosed with spine diseases from categories used to determine the spine specialty hospital designation by the Ministry of Health and Welfare. Treatments for spine-related diseases included surgical procedures (discectomy, excision of intraspinal lesion, spinal fusion with deformity, spinal fusion, amputation, radical excision of malignant bone tumor, osteotomy and external fixation of extremity, etc.) and medical procedures specific to spinal disorders and injuries, osteomyelitis, connective tissue malignancy, connective tissue disorders, other musculoskeletal disorders, etc. We were able to access claims reported during the 7 months after the government began to designate specialty hospitals on November 1, 2011 (November.01.2011–May.31.2012) and included claims reported in the same 7-month period 1 year prior (November.01.2010–May.31.2011). Among nearly 1,600 hospitals

included in the database, only those that admitted more than one spinal-related inpatient case were included. Our analysis encompassed 645,449 patients hospitalized for spine-related illnesses nationwide during the study period, and 823 hospitals including 17 spine specialty hospitals.

Outcome Measures

Inpatient charges per case are the sum of Fee-For-Services (FFS) claims for each patient's hospitalization. LOS is measured as the number of inpatient days during each episode of hospitalization. We also calculated inpatient charge per day by dividing inpatient charges per case by the LOS. In Korea, the FFS schedule is negotiated by the government, medical providers, and other stakeholders every year. In 2012, the FFS catalogue increased by 1.9%, but there were no increases in 2010 and 2011. Hence, we discounted 2012 inpatient charges to 2010–2011 levels. The average foreign exchange rate in 2011 was 1 USD = 1108.09 KRW. Using the claim sample, we also calculated readmission within 30 days of discharge and mortality within 30 days of admission date as a binary variable if a patient was re-hospitalized soon after discharge or died during hospitalization.

Covariates

This dataset contained inpatient claim details, including patient ID, disease diagnosed, admission/discharge date, sex, age, complexity of illness, and the hospital to which each patient was admitted. Complexity of illness was measured by the provider and reported as claim data using the complication or comorbidity level [CCL 0=patient does not have a complication or comorbidity (CC), 1=patient has a minor CC, 2=patient has a moderate CC, 3=patient has a complex CC)] when each patient was admitted. Patient claims data were matched to the hospitals where each patient was admitted.

Hospital-level data included characteristics of the hospital, such as hospital type (specialty, tertiary, large, small), number of beds (in 100 bed increments), specialists per 100 beds, nurses per 100 beds, hospital location (metropolitan if located in cities with a population of more than one million), teaching status, and bed occupancy rate. According to the Korean Hospital Association (KHA), Korean hospitals are categorized into three

categories based on bed size: 1) hospitals with over 1,000 beds: tertiary research university hospitals, 2) hospitals with 300–1,000 beds: mid-sized general hospitals, and 3) hospitals with 100–300 beds: small general hospitals. Both the specialty hospitals and the small general hospitals in our study fell within category 3 (small-general hospitals).[21] The hospital level data obtained from agency for Health Insurance Review & Assessment Services. In order to investigate post policy designation effect, we included interaction term of type of hospital and year which we named designation effect.

We also included data envelopment analysis (DEA) using efficiency as the dummy variable (1=efficient, 0=non-efficient) to determine whether hospitals were operated efficiently using a conventional technical efficiency measuring technique.[22] It is derived from microeconomics methodology that input and output combinations are depicted using a production function to measure multiple decision-making units' (DMUs, here hospitals) efficiency when the production process presents a structure of multiple inputs and outputs.[22] Input variables included number of beds, surgical beds, recovery beds, specialists, residents, nurses, physical therapists, pharmacists, and Positron Emission Tomography (PET), Computer Tomography (CT), and Magnetic Resonance Imaging (MRI) units of each hospital. Output variables included total number of inpatient cases and sum of charges in both 2011 and 2012 study periods for each hospital. Hospital-level statistics were collected based on their first quarter of 2012 status, which was the only available dataset at the time of this study.

Analytical Approach

Mean and standard deviation were analyzed for continuous variables, frequency and percent were analyzed for categorical variables. Univariate analysis of inpatient charges, LOS, readmission within 30 days of discharge, and mortality within 30 days of admission was performed to investigate the unadjusted effects of hospital types on these measures. Analysis of variance and chi-square tests were performed for identification of group differences. Because the unit of analysis was each patient's hospitalization, this study utilized multi-level generalized estimating equation regression (GEE) models in order to avoid problems created by possible nesting of patient observations in hospitals and overestimation of significance.

The GEE regression models were used to investigate the performance and characteristics of specialty hospitals, including the inpatient charges, LOS, readmission, and mortality adjusting for patient- and hospital-level confounders. Because the distributions of continuous dependent variables (inpatient charges & LOS) were skewed, we utilized log transformation in order to improve the distribution characteristics of the data. In addition, we ran the GEEs of the binary outcome variables for readmission within 30 days of discharge and mortality within 30 days of admission. In order to enhance case mix adjustment, we included the diagnosis and procedure code in the each model. SAS 9.2 (SAS institute, Cary, NC) was used for all calculations and analyses. The dataset does not have patient identification information, no ethics committee approval is required.

Results

[Inset Table 1 Here]

A total of 645,449 patients nationwide were hospitalized for spinal disease during the study periods, and 17 specialty hospitals accounted for 45,649 (7.1%) patients nationwide admitted for spine disease. Patients in spine specialty hospitals were aged and female, have had more surgical procedures, and have lower CCL scores. The increase in volume in 2012 compared to 2011 was greater than average in specialty hospitals as well as in conventional hospitals (total: 12.9% vs. specialty 17.8%).

[Inset Table 2 Here]

Table 2 shows the hospital characteristics analyzed. Of the 823 hospitals in our study, there were 17 Ministry of Health and Welfare-designated spine specialty hospitals (2.1% of the total), which accounted for 7.1% of the total spinal procedures performed nationwide during the study period. While none of these was a teaching hospital, they were located mainly in metropolitan areas, and their structural factors were greater in terms of number of 100 beds, specialists per 100 beds, and nurses per 100 beds as well as bed occupancy rate as compared to hospitals in the small-general hospital category. Although specialty hospitals are larger than small-general hospitals in terms of structural factors, both types of hospitals fall within the same small hospital category in Korea. Clinical staffs were larger in spine specialty hospitals than in mid-sized general hospitals. Furthermore, 11.8% of specialty hospitals were considered to be efficient compared with 6.8% of all hospitals.

[Inset Table 3 Here]

Univariate analysis of outcome variables (see Table 3) revealed that inpatient charges per case were lowest in spine specialty hospitals; however, per day charges were larger than small and mid-sized general hospitals. LOS was 10.9 days per admission, which was comparable to tertiary research hospitals, but was much shorter than small and mid-sized general hospitals. Readmission within 30 days of discharge was much lower for the spine specialty hospitals than other hospital types. Death within 30 days of admission also was lowest in specialty hospitals; however, the case was very rare in all types of hospitals because spinal procedures typically are not based on life-threatening conditions. Lower charges per case, charges per day, and reduced LOS were observed among specialty hospitals during the post-designation period.

[Inset Table 4 Here]

The results of our multi-level GEE regression analysis are presented in Table 4. Although spine specialty hospitals had a 2.8% higher inpatient charge per case than small-general hospitals, the difference was not statistically significant. An effect of the official "specialty" designation was found with regard to inpatient charge per case, with charges per case decreasing 6.6% after specialty status was conferred. Spine specialty hospitals charged an average of 27.4% more than small-general hospitals on a per-day basis, although the LOS at spine specialty hospitals was 23.5% shorter. Moreover, charges per case decreased 7.6% and LOS was reduced by 1.0% after specialty status was conferred. The odds of readmission were Odds Ratio (OR)=0.796 for the spine specialty hospitals compared to small-general hospitals; however, the odds of mortality were not statistically significant. This "designation effect" was not noted for either readmission or mortality outcomes. Efficient hospitals were more likely to follow the trend of spine specialty hospitals in terms of charging and LOS. Males were associated with higher charges per case and per day, but shorter LOS. Patients with higher CCL scores had greater charges per case and longer LOS. Hospitals located in metropolitan areas had higher charges per case and shorter LOS. Teaching hospitals had higher charges per case but no significant difference in charge per day or LOS when compared to non-teaching hospitals. Hospital structural factors also were associated with outcome variables; however, the effects were minimal.

Discussion

In this study, we investigated the performance and efficiency of spine specialty hospitals versus general hospitals and examined the effect of "specialty" hospital designation on hospital operating efficiency. Our dataset included spine specialty hospital designation criteria, and nationwide inpatient claims in South Korea. Our univariate results showed that charges per inpatient case were lower and LOS were much shorter for specialty hospitals; however, per day charges were higher than other hospitals with the exception of tertiary hospitals. The results of multivariate analysis, after adjusting for patient- and hospital-level confounders, showed that while spine specialty hospital charges on a per case basis were similar to those of small-general hospitals, the per day charges were 27.4% higher; however, the higher per day charges was balanced by 23.5% shorter LOS. Following "specialty" hospital designation, inpatient charges per case declined by 6.6%, because of shorter LOS (1.0%) and lower per day charges (7.6%) than general hospitals of comparable size.

Although this study considered only short-term effects of the "specialty" designation, spine specialty hospitals appeared to be motivated to reduce their charges. This effect suggests that spine specialty hospitals increased their efficiencies because of their spine specialization and resulting positive volume outcome relationship.[23,24] Therefore, these hospitals were able to reduce overall costs and charge less than other hospitals. This finding also indicates that the "specialty hospital" designation influenced spine specialty hospitals to reduce the financial burden on their patients.

Our findings also revealed that specialty hospitals had much shorter LOS for each spine inpatient. This result supports the premise that specialty hospital physicians have more experience due to their sheer volume, which also allows the specialty hospital to emphasize efficiency by reducing LOS. Shorter LOS for the specialty hospitals was superior to small, mid-sized general hospitals and also was better than tertiary hospitals. However, higher per day charges indicated that specialty hospitals ensure financially viability via high volume and bed turnover. In order to be designated a specialty hospital in Korea, an institution must meet strict institutional requirements, including having a certain number of beds and physicians in addition to operating a specialty medical service department. This process requires a substantial investment by the institution. Since no additional reimbursements or financial subsidies for specialty hospitals exist, might be only marketing effect, institutions ensure financial viability by increasing their efficiency. In addition, the results of our study also provide empirical research confirming the arguments of opponents of specialty hospitals that saying specialty hospitals may provide health care services at greater profit or cherry picking patients more than traditional hospitals.[6,17,18,20] Higher proportion of low CCL patients and surgery rate may support propositions of opponents.

Furthermore, specialty hospitals are most commonly located in metropolitan areas and therefore incur high rent, payroll, and other operating costs. Therefore, the overall operating costs for specialty hospitals are often higher than those for hospitals that are located in non-metropolitan areas.[25] This demographic would suggest that specialty hospitals offset their high operating costs by charging more per day for a shorter LOS, thus increasing patient volume and bed turnover. DEA results also indicated that in order for hospitals to achieve operational efficiency, they might have shorter LOS (24.1%) and higher charge per day (22.8%) than non-efficient hospitals, although charge per case is similar. This finding supports the trend observed for higher specialty hospital efficiency with regard to patient charges and LOS.

Comparing quality measures between specialty hospitals and small-general hospitals of similar size, readmission within 30 days of discharge was 20% lower (OR=0.796) in spine specialty hospitals but was similar to larger hospitals (mid-sized, tertiary hospitals). This quality measure might be better in spine specialty hospitals because of their higher patient volume and much stronger medical experience in the area of spine disease. However, we did not find any association with mortality within 30 days of admission to spine specialty hospitals. We would expect very few cases of mortality among all types of hospitals since spine disease procedures typically are not life-threatening. Of note, our study was only able to evaluate in-hospital mortality, which might underestimate actual mortality cases.

This study has several limitations worth considering; therefore, the results must be interpreted with caution. The potential limitation of our study involves our measurement of the effect of "specialty" designation status. Because of the relatively recent establishment of the specialty hospital designation system (11.01.2011), there has not been sufficient time to thoroughly investigate the effects of the "specialty" designation on hospital operating efficiency. Additional studies using more robust datasets should be performed to better inform long-term policy on spine specialty hospitals. Furthermore, this study may not fully adjust case-mix adjustment although the analysis models include current diagnosis and procedure code, due to the nature of claims data. In addition, we did not have access to information about non-NHI covered procedures, which is important because non-covered services are typical in spine-related procedures. Our study also lacked patient satisfaction records or socio-economic-status (SES) data that may have affected the results of our study.[26]

The other limitation was the inability to analyze hospital financial performance. Because we did not include institutions' financial statements or costs, it was not possible to examine the real financial viability of hospitals. Therefore, the actual revenue, costs, profit, and financial viability and their possible impact on our results remain unknown.

Although our study involved only spine-related inpatient claim data, it represents, to the best of our knowledge, one of only a few studies to evaluate the performance and characteristics of specialty hospitals in this country and outside United States as well. Our conclusions add to the mounting evidence about the greater efficiency and cost benefits of specialty hospitals; these results contribute to the reasoning for designing "specialty" designation requirements and implementing specialty hospital systems in health policy perspective. In order to strengthen the reliability and generalizability of our findings, additional studies investigating the effect of "specialty" designation status over a longer time frame are needed.

Conclusion

In conclusion, our study showed that spine specialty hospitals have higher per day inpatient charges and much shorter LOS than other types of hospitals due to their specialty volume and experience. Specialty hospitals endeavor to be more efficient after governmental "specialty" designation. In addition, the patient readmission rate was lower for specialty hospitals than general hospitals. To promote a successful specialty hospital system, a broader discussion that includes patient satisfaction and the real cost of care, should be initiated.

Financial Disclosure

The entire study was conducted without external funding.

Conflicts of Interests

None of the authors have any conflicts of interest associated with this study.

Author Contributions

S.J.K. designed the study, researched data, performed statistical analyses, and wrote the manuscript. J.W.Y., S.G.L., T.H.K., K.T.H. and E.C.P. contributed to the discussion and reviewed and edited the manuscript. E.C.P. is the guarantor of this work, and, as such, had full access to all data in the study and accepts responsibility for the integrity of the data and the accuracy of the data analysis. All authors fulfilled the authorship criteria given by the ICMJE guidelines.

Acknowledgements

The manuscript is prepared with the manner of honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned.

Ethical approval

Not required.

Data sharing

No additional data available.

References

1. OECD. OECD Reviews of Health Care Quality: Korea 2012. OECD Publishing.
2. Kwon S. Payment system reform for health care providers in Korea. *Health Policy and Planning*. 2003;18:84-92.
3. Lee KS, Chun KH, Lee JS. Reforming the hospital service structure to improve efficiency: urban hospital specialization. *Health Policy*. 2008;87:41-49.
4. Ministry of Health and Wel-fare. http://stat.mw.go.kr [In Korean].
5. Kim J. Hospital performance and their foster plan. *Seoul. Korean Instiute of Hospital Management*. 2005.
6. Iglehart JK. The emergence of physician-owned specialty hospitals. *New England Journal of Medicine*. 2005;352:78-84.
7. Carey K, Burgess JF, Jr., Young GJ. Specialty and full-service hospitals: a comparative cost analysis. *Health Serv Res*. 2008;43:1869-1887.
8. Al-Amin M, Zinn J, Rosko MD, et al. Specialty hospital market proliferation: Strategic implications for general hospitals. *Health Care Management Review*. 2010;35:294-300.
9. Barro JR, Huckman RS, Kessler DP. The effects of cardiac specialty hospitals on the cost and quality of medical care. *Journal of health economics*. 2006;25:702-721.
10. Mitchell JM. Utilization changes following market entry by physician-owned specialty hospitals. *Medical Care Research and Review*. 2007;64:395-415.
11. Swartzmeyer S, Killoran C. Specialty hospital ban was premature. Studies would have shown whether those facilities help or harm healthcare. *Modern healthcare*. 2004;34:21.
12. Herzlinger R. “Specialty Hospitals, Ambulatory Surgery Centers, and General Hospitals: Charting a Wise Public Policy.” Conference held on September 10, Washington, DC. Waltham, MA: Council on Health Care Economics and Policy, 2004.
13. Porter ME, Teisberg EO. Redefining competition in health care. *Harv Bus Rev*. 2004;82:64-76, 136.
14. Casalino LP, Devers KJ, Brewster LR. Focused factories? Physician-owned specialty facilities. *Health Affairs*. 2003;22:56-67.
15. Medicare Payment Advisory Commission. Report to the Congress: physician-owned specialty hospitals. 2005.
16. United States General Accounting Office. Specialty Hospitals : Geographic Location, Services Provided, and Financial Peformance, Washington, DC. 2003.
17. Moore K, Coddington D. Specialty hospital rise could add to full-service hospital woes. *Healthcare financial management: journal of the Healthcare Financial Management Association*. 2005;59:84.
18. Nallamothu BK, Rogers MA, Chernew ME, et al. Opening of specialty cardiac hospitals and use of coronary revascularization in Medicare beneficiaries. *JAMA: the journal of the American Medical Association*. 2007;297:962-968.
19. Kahn CN, 3rd. Intolerable risk, irreparable harm: the legacy of physician-owned specialty hospitals. *Health Aff (Millwood)*. 2006;25:130-133.
20. American Hospital Association. Impact of limited-service providers on communities and full-service hospitals trendwatch. *trendwatch*. 2004;6(2):1-8.
21. Korean Hospital Association. Hospital Management Statistics. 2011.

22. Charnes A, Clark CT, Cooper W, Golany B: A developmental study of data envelopment analysis in measuring the efficiency of maintenance units in the US air forces. *Annals of Operations Research* 1984;2(1):95-112.
23. Tsugawa Y, Kumamaru H, Yasunaga H, et al. The Association of Hospital Volume With Mortality and Costs of Care for Stroke in Japan. *Medical Care*. 2013;51:782-788.
24. Coté GA, Imler TD, Xu H, et al. Lower Provider Volume is Associated With Higher Failure Rates for Endoscopic Retrograde Cholangiopancreatography. *Medical Care*. 2013;51:1040-1047.
25. Kim SJ, Park EC, Jang SI, et al. An analysis of the inpatient charge and length of stay for patients with joint diseases in Korea: Specialty versus small general hospitals. *Health Policy*. 2013;113:93-99.
26. Perelman J, Closon MC. Impact of socioeconomic factors on in-patient length of stay and their consequences in per case hospital payment systems. *Journal of health services research & policy.* 2011;16(4):197-202.

Table 1. Characteristics of patients

	Total		Specialty Hospital		Tertiary Hospital		Mid-sized Hospital		Small Hospital		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Number of Cases	645,449		45,649	7.1	132,972	20.6	208,431	32.3	258,397	40.0	
Age*	52.6	19.7	55.8	15.5	47.3	23.0	53.5	20.5	54.1	17.1	<.0001
SEX											
Male	292,744	45.4	20,795	45.6	62,981	47.4	98,715	47.4	110,253	42.7	<.0001
Female	352,705	54.6	24,854	54.4	69,991	52.6	109,716	52.6	148,144	57.3	
Year											
Pre-Designation	303,220	47.0	20,956	45.9	64,173	48.3	100,647	48.3	117,444	45.5	<.0001
Post-Designation	342,229	53.0	24,693	54.1	68,799	51.7	107,784	51.7	140,953	54.5	
*** Volume increase in Post-Designation**	12.9%		17.8%		7.2%		7.1%		20.0%		
CCL Score											
0	436,621	67.6	32,190	70.5	93,631	70.4	124,595	59.8	186,205	72.1	<.0001
1	140,158	21.7	9,897	21.7	24,330	18.3	51,641	24.8	54,290	21.0	
2	56,346	8.7	3,114	6.8	11,974	9.0	25,939	12.4	15,319	5.9	
3	12,324	1.9	448	1.0	3,037	2.3	6,256	3.0	2,583	1.0	
Procedure Type											
Surgical	579,853	89.8	45,386	99.4	101,431	76.3	185,151	88.8	247,885	95.9	<.0001
Medical	65,596	10.2	263	0.6	31,541	23.7	23,280	11.2	10,512	4.1	

*** Mean/SD**

Table 2. Characteristics of hospitals

	Total		Specialty Hospital		Tertiary Hospital		Mid-sized Hospital		Small Hospital		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Number of Hospitals*	823		17	2.1	44	5.3	267	32.4	495	60.1	
Geographic											
Metropolitan area	439	53.3	14	82.4	33	75.0	129	48.3	263	53.1	0.001
Non-metropolitan area	384	46.7	3	17.6	11	25.0	138	51.7	232	46.9	
Teaching Status											
Teaching	149	18.1	-	0.0	44	100.0	102	38.2	3	0.6	<.0001
Non-Teaching	674	81.9	17	100.0	-	0.0	165	61.8	492	99.4	
DEA Efficiency											
Efficient	56	6.8	2	11.8	-	0.0	3	1.1	51	10.3	<.0001
Non-Efficient	767	93.2	15	88.2	44	100.0	264	98.9	444	89.7	
Number of 100 beds*	4.5	4.8	1.4	0.6	11.7	5.5	4.4	2.1	1.3	0.7	<.0001
Number of specialists per 100 beds*	14.7	8.1	15.7	5.6	25.9	7.1	13.7	5.4	9.5	4.0	<.0001
Number of nurses per 100 beds*	50.3	24.2	60.0	23.9	74.1	16.9	54.8	19.7	32.7	16.2	<.0001
Bed occupancy rate*	85.2	16.9	83.0	10.5	98.7	9.1	85.5	13.6	78.5	19.1	<.0001

*** Mean/SD**

Table 3. Univariate analysis of dependent variables by hospital types

	Specialty Hospital							Tertiary Hospital						
	Total		Pre-Designation		Post-Designation		P	Total		Pre-Designation		Post-Designation		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD		N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Charges per case [KRW]*	2,357,468	1,619,618	2,375,527	1,550,231	2,342,143	1,676,132	0.028	3,059,806	2,688,264	2,856,209	2,289,087	3,249,713	3,000,898	<.0001
Charges per day [KRW]*	251,661	150,845	252,214	164,000	251,191	138,707	0.471	323,255	231,344	311,785	223,778	333,953	237,687	<.0001
Length of Stay [Days]*	10.9	7.3	11.2	7.7	10.6	7.0	<.0001	10.6	9.2	10.7	9.4	10.5	9.1	<.0001
Readmission within 30 days of discharge														
Yes	505	1.11%	234	1.12%	271	1.10%	0.846	9,275	6.98%	4,408	6.87%	4,867	7.07%	0.142
No	45,144	98.89%	20,722	98.88%	24,422	98.90%		123,697	93.02%	59,765	93.13%	63,932	92.93%	
In-Hospital death within 30 days of admission														
Yes	1	0.00%	1	0.005%	-	0.0%	0.278	352	0.26%	172	0.27%	180	0.26%	0.821
No	45,648	100.00%	20,955	99.995%	24,693	100.0%		132,620	99.74%	64,001	99.73%	68,619	99.74%	

	Mid-sized Hospital							Small Hospital						
	Total		Pre-Designation		Post-Designation		P	Total		Pre-Designation		Post-Designation		P
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD		N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Charges per case [KRW]*	3,028,064	2,352,461	2,891,420	2,082,341	3,155,660	2,572,744	<.0001	2,559,995	2,170,122	2,479,704	2,050,050	2,626,895	2,263,145	<.0001
Charges per day [KRW]*	234,173	178,011	229,703	182,652	238,347	173,462	<.0001	246,804	180,053	245,242	190,559	248,106	170,796	<.0001
Length of Stay [Days]*	15.5	12.2	15.6	12.2	15.4	12.1	<.0001	12.5	9.3	12.6	9.5	12.4	9.2	<.0001
Readmission within 30 days of discharge														
Yes	5,761	2.76%	2,814	2.80%	2,947	2.73%	0.390	4,024	1.56%	1,880	1.60%	2,144	1.52%	0.103
No	202,670	97.24%	97,833	97.20%	104,837	97.27%		254,373	98.44%	115,564	98.40%	138,809	98.48%	
In-Hospital death within 30 days of admission														
Yes	432	0.21%	197	0.196%	235	0.2%	0.263	95	0.04%	38	0.03%	57	0.04%	0.286
No	207,999	99.79%	100,450	99.804%	107,549	99.8%		258,302	99.96%	117,406	99.97%	140,896	99.96%	

*** Mean/SD**

Table 4. Multi-level GEE analysis of inpatient charges per case, inpatient charges per day, length of stay, readmission, mortality.

			Ln_Charges per case		Ln_Charges per day		Ln_LOS		Readmission within 30 days of discharge		In-Hospital death within 30 days of admission	
			Est. [%]	P	Est. [%]	P	Est. [%]	P	Odds Ratio	P	Odds Ratio	P
Patient Level	Age		0.002	<.0001	0.001	<.0001	0.001	<.0001	0.995	<.0001	1.030	<.0001
	SEX											
		Male	0.015	<.0001	0.040	<.0001	-0.025	<.0001	0.938	<.0001	1.245	0.002
		Female	Ref.									
	CCL Score											
		1	0.181	<.0001	-0.038	<.0001	0.218	<.0001	1.127	<.0001	4.097	<.0001
		2	0.314	<.0001	-0.001	0.574	0.315	<.0001	1.009	0.758	22.218	<.0001
		3	0.533	<.0001	0.064	<.0001	0.469	<.0001	1.264	<.0001	185.824	<.0001
		0	Ref.									
	Year											
		2012	0.068	<.0001	0.072	<.0001	-0.004	0.143	0.987	0.699	1.250	0.292
		2011	Ref.									
Hospital Level	Hospital Type											
		Specialty hospital	0.028	0.605	0.274	<.0001	-0.235	<.0001	0.796	0.002	0.295	0.230
		Tertiary hospital	0.313	<.0001	0.479	<.0001	-0.138	0.036	1.005	0.918	1.380	0.172
		Mid-sized hospital	0.229	<.0001	0.175	<.0001	0.067	0.007	0.971	0.465	1.399	0.094
		Small Hospital	Ref.									
	Designation Effect											
		Specialty hospital	-0.066	<.0001	-0.076	<.0001	-0.010	0.013	0.961	0.679	0.000	0.884
		Tertiary hospital	0.024	<.0001	0.023	<.0001	0.001	0.827	1.062	0.148	0.720	0.168
		Mid-sized hospital	0.001	0.836	0.004	0.241	-0.003	0.459	1.073	0.105	0.866	0.538
	DEA Efficiency											
		Efficient	-0.020	0.529	0.228	<.0001	-0.241	<.0001	0.977	0.508	0.556	0.064
		Non-Efficient	Ref.									
	Geographic											
		Metropolitan area	0.021	0.184	0.060	0.001	-0.038	0.054	0.994	0.792	0.948	0.521
		Non-metropolitan area	Ref.									
	Teaching Status											
		Teaching	0.048	0.039	0.023	0.232	0.026	0.256	0.801	<.0001	1.072	0.567
		Non-Teaching	Ref.									
	Number of 100 beds		-0.007	0.125	-0.004	0.395	-0.004	0.460	1.014	<.0001	1.003	0.801
	Number of specialists per 100 beds		-0.005	<.0001	0.004	<.0001	-0.009	<.0001	1.020	<.0001	1.004	0.609
	Number of nurses per 100 beds		-0.001	<.0001	0.001	0.000	-0.003	<.0001	0.998	<.0001	1.004	0.099
	Bed occupancy rate		0.002	<.0001	0.001	0.635	0.002	<.0001	1.000	0.672	0.998	0.483

Note: Each model was adjusted by diagnosis and procedure codes

As we described in the manuscript, this study used health insurance claim dataset. We do believe the STOBE checklist is most relevant form. Thank you.

	Item No	Recommendation	Page NO
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	In abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	In abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, explain how loss to follow-up was addressed	-
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	In table
		(b) Indicate number of participants with missing data for each variable of interest	In table
		(c) Summarise follow-up time (eg, average and total amount)	In table
Outcome data	15*	Report numbers of outcome events or summary measures over time	In table
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted	In table

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	In table
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10-11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12