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Evaluation of a Center of Excellence Program for Spine Surgery

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Abstract

Background—The Centers for Medicare and Medicaid Services and many private health plans are encouraging patients to seek orthopedic care at hospitals designated as centers of excellence. No evaluations have been conducted to compare patient outcomes and costs at centers of excellence versus other hospitals. The objective of our study was to assess whether hospitals designated as spine surgery centers of excellence by a group of over 25 health plans provided higher quality care.

Methods—Claims representing approximately 54 million commercially insured individuals were used to identify individuals aged 18–64 years of age with one of three types of spine surgery in 2007–2009: one or two level cervical fusion (referred to as cervical simple fusion), one or two level lumbar fusion (referred to as lumbar simple fusion), or lumbar discectomy and/or decompression without fusion. The primary outcomes were any complication (7 complications were captured) and 30-day readmission. The multivariate models controlled for differences in age, gender, and comorbidities between the two sets of hospitals.

Results—A total of 29,295 cervical simple fusions, 27,214 lumbar simple fusions, and 28,911 lumbar discectomy/decompressions were identified, of which 42%, 42%, and 47%, respectively, were performed at a hospital designated as a spine surgery center of excellence. Designated hospitals had a larger number of beds and were more likely to be an academic center. Across the three types of spine surgery (cervical fusions, lumbar fusions, or lumbar discectomies/ decompressions), there was no difference in the composite complication rate (OR 0.90 (95% CI 0.72–1.12), OR 0.98 (95% CI 0.85–1.13), OR 0.95 (95% CI 0.82–1.07) respectively) or readmission rate (OR 1.03 (95% CI 0.87–1.21), OR 1.01 (95% CI 0.89–1.13), OR 0.91 (95% CI 0.79–1.04) respectively) at designated hospitals compared to other hospitals.

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Conclusions—On average, spine surgery centers of excellence had similar complication rates and readmission rates compared to other hospitals. These results highlight the importance of empirical evaluations of centers of excellence programs.

INTRODUCTION

In an effort to improve the quality of care patients receive,[7,25,47] some commercial and public payers are requiring or encouraging patients to obtain care at centers of excellence.[43] The Centers for Medicare and Medicaid Services (CMS) has adopted a policy to only cover bariatric surgery when performed at a center of excellence.[14] Commercial health plans and professional organizations have also designated centers of excellence for numerous conditions and procedures.[1,4,16]

Centers of excellence are hospitals that have earned that designation based on a broad set of evidence-based criteria,[26] including volume of cases,[7,35] training of providers,[41] availability of computerized physician order entry,[6,29] performance on process quality metrics,[42] discharge planning,[37] and nursing-patient ratios.[3,28] Although many of the criteria for selecting centers of excellence are supported by evidence, systematic assessment of whether centers of excellence have better outcomes and costs is lacking.[30] Evaluations of one centers of excellence program for bariatric surgery found no clinically significant differences in outcomes or costs.[8,32]

The focus of the study is a centers of excellence program for spine surgery established in 2007 by a group of over 25 health plans from across the country that collectively provide healthcare coverage for over 90 million Americans. The purpose of the study is to compare the outcomes and costs for selected types of spine surgery at 369 hospitals designated as centers of excellence to 1,449 other hospitals without this designation. The study hypothesis is that hospitals designated as centers of excellence have better outcomes and lower costs than other hospitals.

METHODS

Criteria for Designation as Center of Excellence for Spine Surgery

Spine surgery is a good candidate for a centers of excellence program because spine surgeries are typically elective inpatient procedures that are performed frequently and are associated with significant variability in complication rates and costs.[21,22,48] To be designated as a center of excellence in this program, hospitals complete an application form with specific information such as surgeon and hospital volume, use of multidisciplinary care pathways and teams, electronic medical records, length of stay, and commitment to quality improvement (all criteria are listed in Table 1). **(CME)** Hospitals that meet the set of required criteria and achieve a certain score on the remaining items are designated as a center of excellence for spine surgery. The designation process was started in 2009 and completed in 2010.

Data Sources

All inpatient and outpatient utilization data for the years July 1, 2007 through December 31, 2009 were analyzed using a database of the de-identified health insurance claims for approximately 54 million members from 19 health plans in the consortium. A unique patient identifier allowed linkage of care over time.

Hospital Sample

Using hospital name, state, and zip code, hospitals with at least one spine surgery were matched to the 2008 American Hospital Association (AHA) hospital characteristics database. Hospitals that could not be linked because of incomplete information were excluded from the analysis. We excluded all hospitals in 7 states in which no hospitals applied for designation in the spine surgery program.

Based on Medicare hospital identifiers in the AHA database, 2008 hospital-level data on patient experience[24] and surgical quality measures (Surgical Care Improvement Project)[9] were extracted from the Medicare Hospital Compare database.[44]

Classifying Spine Surgery by Type

Building on the classification system developed by Deyo and colleagues,[22] each spine surgery case was classified into nine categories based on type of surgery (simple fusion with or without discectomy/decompression, complex fusion with or without discectomy/decompression, and discectomy/decompression without fusion) and by level of surgery (cervical, thoracic/thoracolumbar, and lumbar). A simple fusion involves a single surgical approach (i.e., only anterior fusion or only posterior fusion), and only one or two levels. All other fusions were classified as complex. The discectomy/decompression category includes any cases with a procedure code for discectomy or decompression excluding all cases with a procedure code for fusion. The level of surgery was classified using relevant International Classification of Diseases, Ninth Revision, Clinical Modification procedure codes. Details on the codes used are in the Appendix.

We restricted the comparison of outcomes and costs to three categories of spine surgery: (1) cervical simple fusion with or without discectomy/decompression, (2) lumbar simple fusion with or without discectomy/decompression, and (3) lumbar discectomy/decompression without fusion. The analyses were restricted to these three categories of spine surgery because they made up the vast majority of spine surgery cases and there was insufficient sample size in other categories to detect differences between the hospitals. In addition, the clinical indications for more complex, multilevel, or dual approach spine fusion surgeries are more heterogeneous, making risk adjustment more difficult.

Patient Sample

Our analyses focused on patients with spine surgery in the 27-month period from July 2007 through September 2009. We obtained claims from January 1, 2007 through December 30, 2009 which allowed for a 180-day “clean period” before and a 90-day follow-up period after each spine surgery.

Based on methods in prior studies of spine surgery, we also excluded those less than 18 years, those 65 years and older, those patients for which we might not have all claims (e.g., not continuously enrolled in health plan during time period); complex fusion (both anterior and posterior fusion approaches and/or a fusion of 4 or more vertebrae);[22] surgery performed on multiple levels of the spine;[22] another primary or revision fusion surgery in the 6 months before procedure; pregnancy;[2,19,45,46] spinal cord injuries, spine fractures, and vertebral dislocations;[11,18,19,22,45,46] accidents; disc prosthesis; use of bone morphogenetic protein; pathologic fractures, malignant neoplasms;[12,18,19,22,45] congenital spine disorders;[12,19] inflammatory spondylopathies;[22,45,46] abscess or osteomyelitis;[12,18,19,22] postlaminectomy syndrome;[18] emergency department admission; and those who left the hospital against medical advice. We excluded those 65 years and older because it might not be possible to capture all of their claims and costs due to Medicare coverage. The justification for the other criteria, the number of cases excluded, and codes and time periods used are in the Appendix.

Outcome Measures

We created clinical outcome measures for spine surgery based on similar measures for knee and hip replacement developed recently for the CMS by researchers at Yale University.[36] We used the same specifications as the CMS measures for four complications (i.e., acute myocardial infarction, pneumonia, sepsis, and pulmonary embolism). These were identified during the index hospitalization or a readmission to any hospital using specified diagnoses and procedures within a specified time period (i.e., 7 or 30 days) which varies by complication (see Appendix for details). In contrast to the CMS measure, which looked at 30-day mortality, mortality in our study was identified based on the discharge status of the index admission, because information on mortality after discharge is not consistently available in health plan claims as patients may die at home. However, we can capture other complications post-discharge that require medical care as those are captured in health plan claims. We added two more complications (wound complications, repeat spine surgery). Based on prior studies, wound complications were identified using International Classification of Diseases, Ninth Revision, Clinical Modification diagnosis codes for wound infection, osteomyelitis, arthritis-related infection, or surgical site bleeding. Surgical site bleeding was only flagged if it was associated with a procedure code for incision and drainage, or arthrotomy. Repeat spine surgery was for any type of spine surgery (i.e., fusion, revision fusion, discectomy, or decompression) performed at the same level of the spine (i.e., cervical or lumbar) as the index spine surgery. Wound complications and repeat spine surgery were only flagged during a readmission and not the index admission. During the initial hospitalization, the procedure might be performed for a reason not related to a complication. Also, a diagnosis code for surgical site bleeding during the index hospitalization might indicate normal blood loss. Consistent with prior work[12,13,18,19,22,27,40,45] complications following spine surgery were defined based only on inpatient claims.

A composite complication rate and rates of seven individual complications that make up the composite (acute myocardial infarction, pneumonia, sepsis, pulmonary embolism, wound complications, death, and repeat spine surgery) were estimated. The readmission rate

includes all hospitalizations for any reason within 30 days of the discharge date for the index stay. Transfers to another acute care hospital were included as readmissions; subsequent admissions to an acute rehabilitation hospital or skilled nursing facility were excluded. Detailed specifications for the complications and readmissions including diagnosis and procedure codes are in the Appendix.

The other set of outcomes were total costs for spine surgery episodes for two time periods, a 90-day episode and the index hospitalization. The 90-day period began on the date of the index procedure admission date. This approach has been used in a previous study of Medicare beneficiaries[15] to measure differences in costs between surgery and non-surgery cohorts.

We measured the cost for each service using the "allowed amount", which is the sum of health plan reimbursement and any patient copayment or deductible. Reimbursement for a given service can vary from hospital to hospital based on prior negotiations. Episode costs were the sum of the allowed amount for all inpatient and outpatient claims during that period. The index hospitalization cost was the cost of only services provided during the first hospitalization. Pharmacy costs were not included in the cost analyses because pharmacy claims data were not available for all patients. All cost calculations included both facility and physician services.

Covariates

In comparing the two sets of hospitals, age, gender, and 26 comorbidities were used to adjust the rates in a model similar to that designed for the CMS measures for other orthopedic procedures.[31] Because of the low rate of complications and large number of covariates, some models did not converge; these were re-specified with age, gender, and four comorbidities (i.e., hypertension, diabetes, chronic atherosclerosis, and vascular disease) as covariates. We identified patients as having a comorbidity based on diagnoses coded on inpatient and outpatient claims during the 6 months before the index spine surgery. The comorbidities were classified using the CMS Condition Category system (see Appendix for definitions). Because we have access only to cases that were paid for by these plans, we do not know how many procedures were performed in total at a given hospital or by a given surgeon. Therefore, we do not control for volume of procedures. Using other data, we know that the designated hospitals had more hospital beds and had a higher surgical volume.

Statistical Analysis

All statistical analyses were conducted using SAS (SAS Institute, Cary, NC, 2010). For the descriptive analyses, we tested for differences using chi-square tests for categorical data and Student's *t* tests for continuous data.

To estimate the association between having a complication and designation as a center of excellence, multivariate logistic regression models were used. Each model adjusts for the same set of patient covariates (i.e., age, gender, and 26 or 4 comorbidities described above) and accounted for clustering of cases within hospitals. Because of the low complication and readmission rates, use of hospital random effects in the models was not feasible.

To estimate the association between the costs and designation as a center of excellence, multivariate models were used with a gamma distribution and log link because costs were not normally distributed.[34] The dependent variables for the models were total 90-day costs and costs for the index hospitalization. Each model also includes the same set of patient covariates in the complications model. A hierarchical model with a random effect for each hospital was used to address clustering.[33,39] To account for regional cost variation, a fixed effect for each state was included. Coefficients in log link models are interpreted as the percentage difference in costs associated with a unit change in the variable. To assess for possible residual differences in patient characteristics, we conducted sensitivity analyses in which baseline (i.e., prior 6 months) costs were added to the model. Details on these sensitivity analyses are available in the Appendix.

RESULTS

Hospital Characteristics

Of the 1,818 hospitals with at least one case of the three types of spine surgery, 369 (20.3%) were designated by the group of health insurers as spine surgery centers of excellence. Compared to other hospitals, these designated hospitals were more likely to be located in the Midwest, not for profit, a teaching hospital, in an urban area and have a higher annual total surgical volume and more beds (Table 2). A total of 40.9% of designated hospitals had >400 beds in contrast with 16.5% of other hospitals ($p<0.01$). Designated hospitals also generally performed better on the Surgical Care Improvement Project measures (Table 2). For example, in general, surgical patients at designated hospitals were more likely to receive deep vein thrombosis prophylaxis (92.8% and 89.2%, $p<0.01$). In contrast, designated hospitals had generally the same or lower rates on patient experience measures. For example, patients at designated hospitals were less likely to “definitely recommend the hospital” (23.6% and 25.6%, $p<0.01$). On the other hand, there was no difference in whether their pain was “always” controlled (66.9% designated hospitals and 67.5% other hospitals, $p=0.12$).

Defining Analytic Sample

A total of 191,618 spine surgeries were identified on the claims before any exclusions were made. Of these, 27,602 (14.4%) were excluded from the sample because the hospital identification number was missing and we were unable to link the hospital to the American Hospital Association database. Of the remaining cases 83.8% were one of three types of spine surgery (i.e., cervical simple fusions, lumbar simple fusions, and lumbar discectomies and/or decompressions without fusion) used in our analyses of outcomes and costs (details on defining analytic sample provided in Appendix).

Patient Characteristics

After exclusions, a total of 29,295 cervical simple fusions with or without a discectomy and/or decompression, 27,214 lumbar simple fusions with or without a discectomy and/or decompression, and 28,911 lumbar discectomies and/or decompressions without fusion were identified in the 2007–2009 inpatient claims, of which 42%, 42%, and 47%, respectively, were performed at a designated hospital. In general, patients treated at designated hospitals

and other hospitals were similar in terms of age, gender, and prevalence of comorbidities. However, among lumbar fusion surgery patients, those at designated hospitals were slightly older (41.3% vs. 38.6% aged 55–64 years) and had a higher rate of vascular disease (6.9% vs. 5.9%) than those at other hospitals (Table 3). Among lumbar discectomy/decompression patients, those at designated hospitals had a lower rate of hypertension (35.7% vs. 37.0%) than those at other hospitals.

Complications

For all three types of spine surgery, the rates of any complications requiring a readmission and the 30-day readmission rates were similar at designated hospitals and other hospitals. At designated hospitals and other hospitals, the unadjusted rates of *any complication* were 1.27% vs. 1.38% for cervical simple fusion, 4.12% vs. 4.14% for lumbar simple fusion, and 3.23% vs. 3.42% for lumbar discectomy/decompression, respectively (Table 4). Similarly, at designated hospitals and other hospitals, the unadjusted rates of *30-day readmission* were 2.32% vs. 2.25% for cervical simple fusion, 5.23% vs. 5.13% for lumbar simple fusion, and 3.55% vs. 3.86% for lumbar discectomy/decompression, respectively. Our adjusted analyses had similar findings. After adjusting for age, gender and comorbidities, differences between the designated and other hospitals in the overall or specific complication rates or 30-day readmission rates were not statistically significant for any of the three types of spine surgery (adjusted odds ratios provided in Table 4).

90-day Costs

Patients at hospitals designated as centers of excellence had similar mean unadjusted 90-day total costs to those for patients at other hospitals for cervical simple fusion ($26,187 and $26,548, respectively), lumbar simple fusion ($44,919 and $45,669, respectively), and lumbar discectomy/decompression ($14,528 and $14,929, respectively) (Table 5). The unadjusted mean costs of the index hospitalization were also similar for designated hospitals and other hospitals for the three types of surgery. After controlling for differences in patient characteristics, neither mean 90-day total costs nor mean costs for the index hospitalization differed significantly between designated hospitals and other hospitals for any of the spine surgeries. Sensitivity analyses that included baseline costs in the model did not produce notable differences in the results (Appendix).

DISCUSSION

Numerous purchasers of health care are creating centers of excellence programs. The underlying premise for these programs is that a hospital designated as a center of excellence provides higher quality care. Yet, in a large national sample of patients having three common types of spine surgery, centers of excellence did not have lower complication rates, 30-day readmission rates or 90-day costs compared to other hospitals. Our results echo recent evaluations of a bariatric surgery centers of excellence program which did not find any differences between the two sets of hospitals.[8,32] In contrast, we have conducted another evaluation of centers of excellence for knee and hip replacement that showed designated hospitals had modestly lower complication and readmission rates for patients undergoing total hip or total kneeeplacement (*in press*).

The lack of a difference in outcomes between the two sets of hospitals is striking and unexpected. The criteria for designation have face validity, including some criteria (e.g., volume of care, electronic medical records) that have been demonstrated to be associated with higher quality. Furthermore, the designated centers are larger, have higher surgical volume, and are more likely to be academic, all characteristics that are generally assumed to be associated with higher quality care. There are several possible explanations for the lack of a difference. First, some hospitals that may qualify may not have submitted an application. This misclassification of "eligible but not designated" hospitals as "other" could attenuate the differences between the two sets of hospitals. However, the designation program conducted a follow up with hospitals that did not respond to the initial call for applications, so there should not be many "eligible but not designated" hospitals. Second, while a panel of experts helped develop the designation criteria, it is still possible that the associations between the individual hospital characteristics used as designation criteria and outcomes may be weak.

For example, one of the criteria to become a designated hospital is higher performance on the publicly-reported Surgical Care Improvement Project measures, yet recent work showed little relationship between performance on the individual measures and patient outcomes.[38] Third, it is possible that designated hospitals are more thorough in recording complications in claims than other hospitals. If the designated hospitals in reality have a lower rate of complications, this more thorough recording of complications might lead to a finding of no difference in complication rates even though one exists. Fourth, given the low complication rate of 2 to 5%, it simply may be difficult to identify a set of structural criteria by which one set of hospitals is clearly superior to other hospitals.

In the analyses reported here, we compare the complication rate at designated hospitals and other hospitals *for specific types of spine surgery*. A separate but related question for future research is whether physicians performing spine surgery at designated hospitals are more likely to choose the appropriate management (fusion vs. discectomy vs. no surgery at all) for a given patient?[10] This is of particular importance as there are concerns that spine surgery may be performed too frequently[20] and fusion surgery might be used when it is inappropriate,[23] both of which could increase spending and lead to more complications. Appropriateness of surgery could be considered as a future criterion to be designated as a center of excellence. However, appropriateness of surgery cannot be assessed using claims data and would require review of medical charts. In addition, hospitals might argue that the appropriateness of surgery is not under their control as it is a decision made by physicians in the outpatient setting.

There are several important strengths and limitations to the study. The key strength is that it is based on a large national sample of patients (our data includes approximately one in six US citizens across 43 states and the District of Columbia) who recently (i.e., 2007–2009) had spine surgery and are insured by commercial health insurance plans. The sample includes the three largest subgroups of spine surgery (i.e., cervical simple fusion, lumbar simple fusion, and lumbar discectomy/decompression). In addition, the data allowed complete identification of specific types of spine surgery and follow-up care after discharge

(e.g., subsequent readmissions to an acute care inpatient hospital) using unique patient identifiers.

Some important limitations include potential bias if patients at the designated or other hospitals differ systematically in their disease severity or the complexity of their surgical treatment in a manner that is not adequately captured by the exclusion and risk-adjustment criteria. For example, it is possible that an unmeasured confounder such as obesity might create bias in our data. However, it is reassuring that for the confounders measured in this study (i.e., age, co-morbidities), there are few differences between the two sets of hospitals. Second, specific complications may be underestimated or misclassified because we chose *not* to include complications only coded on outpatient claims. However, using only inpatient claims increases the likelihood that the rates reflect the more severe complications requiring hospitalization following surgery. Third, our results relate to commercially insured patients 18- 64 years of age having spine surgeries and therefore may not generalize to older patients, or Medicare or Medicaid patients of any age. Fourth, we are examining care provided by designated hospitals over a period (2007–2009) before the hospitals were actually designated as centers of excellence (2009–2010). It is possible that, in the interval, performance substantively improved at the designated hospitals and that in a comparison of care in 2009–2010, we might observe differences in the outcomes between the designated and other hospitals. Finally, because the sample is restricted to three types of spine surgery, the results cannot be generalized to the more uncommon and complex types of spine surgeries that were excluded (e.g., complex fusions).

There were also limitations in the outcomes we tracked in this study. Given what can be accurately captured via analysis of claims, we did not look at several spine-specific complications (e.g., nerve root injury, dural tear) or functional outcomes (e.g., do patients at designated hospitals have greater improvements in pain). The impact on functional outcomes is important because that is typically why patients have surgery. A related point is that given only three years of data were available, we were also unable to assess another possible outcome - mean time to reoperation. Future analyses might also consider adding stroke as another outcome for cervical spine surgery. Finally, we measure costs from the health plan’s perspective. Therefore, our cost measure reflects the negotiated reimbursement and may not address the hospital’s underlying costs in providing care or quality improvement initiatives.

A growing number of health plans are developing centers of excellence programs for inpatient care, yet there have been few comparisons of hospitals with and without a designation as a center of excellence. In this evaluation of a national centers of excellence program for spine surgery, we found on average that there were no differences in complication and readmission rates or in 90-day and index hospitalization costs between hospitals designated as centers of excellence and other hospitals without this designation. The results emphasize the need to empirically evaluate whether centers of excellence programs successfully identify hospitals with improved patient outcomes and lower costs of care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Summary of Program Selection Criteria for Designation as a Center of Excellence for Spine Surgery[a]

Required Criteria	
Comprehensive inpatient facility (ER, ICU and other specialized services)	Required
Accreditation (full facility accreditation by a CMS-deemed national accreditation organization)	Required
Duration of spine surgery service (>12 months)	Required
At least 2 surgeons perform spine surgery and each must be board certified	Required
Program employs or is willing to employ shared decision making processes	Required
Volume (≥100 spine surgeries annually; average and median surgeon ≥50 spine surgeries)	Required
Hospital and surgeons are participating providers in local health plan network	Required
Other Criteria (need 60 out of 100 points)	
Structure – Total Possible 61 points	**Points**
Participation in IHI improvement campaigns (formal commitment to ≥6 campaigns)	2
Reports to Leapfrog or comparable local initiative	1
Accepts AAMC principles for conduct and reporting of clinical trials	1
Health information technology (certified EMR, e-prescribing, medication reconciliation)	3
Nursing excellence (magnet designation or reports to NDNQI)	1
Participates in HCAHPS survey and makes data available on Hospital Compare[b]	1
National Quality Improvement Initiatives (Universal Protocol, WHO Safety Checklist)	1
Participates in SCIP (points for performance and tracking and reporting results)	9
Disclosure policies that address conflict of interest and relationship to device manufacturers	4
Pain management (protocols for peri-operative surgical patients, protocols based on national guidelines, monitoring effectiveness)	4
Dedicated unit (for spine surgery)	2
Multidisciplinary clinical pathways and teams	20
Ongoing continuous quality improvement (e.g., collection of data, development of improvement goals and demonstrated improvement, ongoing physician learning)	2
Data management and patient tracking (internal registry for treatment and outcomes, process to track complications and reoperations, protocol to contact patients for follow-up)	8
Data reporting to a national or international spine database (e.g., NSQIP)	2
Process – Total Possible 28 points	**Points**
Patient selection criteria (written criteria, depression and anxiety screening)	5
Shared decision making protocols established, tools utilized	10
Medical management (utilize established guidelines, such as ADA Standards of Diabetes Care)	2
Thromboprophylaxis protocol specific for spine surgery (incorporates ACCP guidelines)	1
Normothermia surgical protocol established for spine surgery	1
Availability and established protocols for physical therapy and rehabilitation services	3
Functional assessments (standardized indexes for pre- and post-op assessments)	3
Transitions of care protocols established (e.g., discharge planning, monitoring of transitions)	3
Outcomes and Volume—Total Possible 11 points	**Points**
Self-reported complication rates less than thresholds for dural tear, operative blood transfusion	5

Length of stay for spine procedures ≤ 2.5 – 6 days, depending on the procedure performed	4
Tracking and reporting outcomes such as LOS, complications, readmissions, reoperations	2

Abbreviations: AAMC – Association of American Medical Colleges, ACCP – American College of Chest Physician, ADA – American Diabetes Association, IHI – Institute for Healthcare Improvement, LOS – Length of Stay, NSQIP – National Surgical Quality Improvement Program, NDNQI - National Database of Nursing Quality Indicators, SCIP – Surgical Care Improvement Project, WHO – World Health Organization

[a]To be designated as a center of excellence for Spine Surgery, hospitals must have met a number of required criteria and also achieve a score of at least 60 points out of 100 on the rest of the criteria. The selection criteria shown in this table are specific to the 2009 RFI cycle.

[b]Hospital Compare is a tool developed by the Centers for Medicare and Medicaid Services to help consumers compare the quality of care that hospitals provide. It provides a list of U.S. hospitals which includes hospital demographics (e.g., location, hospital type) and 44 quality-of-care measures.

Table 2

Characteristics of Designated Hospitals for Spine Surgery and Other Hospitals, 2008

Hospital Characteristics	Designated Hospitals[a] N=369	Other Hospitals [a] N=1,449	p-value[b]
Structural Characteristics[c]			
Number of Beds-- (% of hospitals)			
<100	2.4	20.4	<0.01
100–400	56.6	63.2	
>400	40.9	16.5	
Region—(% of hospitals)			
West	15.2	16.6	0.12
Midwest	29.5	23.5	
South	37.1	40.5	
Northeast	18.2	19.4	
For profit (% of hospitals)	13.3	22.0	<0.01
Member of COTH (% of hospitals)	31.2	8.6	<0.01
Urban setting (% of hospitals)	100.0	97.0	<0.01
Medical/surgical ICU (% of hospitals)[d]	98.5	90.6	<0.01
Medicare insurance (average % of patients)	42.2	43.9	<0.01
Medicaid insurance (average % of patients)	16.3	16.9	0.25
No. of nurses/1000 patient-days (average)	6.9	8.9	0.12
All surgical operations – inpatient procedures per year (average)	6,689	3,509	<0.01
Patient Experience e (average percentage across all hospitals)			
Nurses “always” communicated well	72.8	73.1	0.33
Doctors “always” communicated well	77.3	78.4	<0.01
Patient “always” received help as soon as they wanted it	58.2	60.2	0.03
Pain was “always” well controlled	66.9	67.5	0.12
Staff “always” explained medicines before giving it to them	57.1	57.6	<0.01
Room and bathroom were “always” clean	64.8	67.3	<0.01
Area around their room was “always” quiet at night	52.1	54.7	<0.01
Patients given information about what to do after discharge	81.6	80.8	<0.01
Rated hospital as 9 or 10 on a scale from 0 to 10 (highest)	65.3	64.2	0.05
Definitely would recommend the hospital	23.6	25.6	<0.01
Surgical Quality of Care f (average percentage across hospitals)			
Patients given antibiotic within one hour before surgery	95.2	93.5	<0.01
Antibiotics stopped within 24 hours	92.4	90.1	<0.01
Patients given appropriate antibiotic	97.6	96.7	<0.01
Patients received appropriate timing of DVT prophylaxis	92.8	89.2	<0.01
Patients received DVT prophylaxis	95.1	91.7	<0.01
Patients received appropriate glucose control	90.7	84.0	<0.01

Hospital Characteristics	Designated Hospitals[a] N=369	Other Hospitals [a] N=1,449	p-value[b]
Patients received appropriate hair removal	98.1	98.1	0.90
Patients on beta blockers continued on beta blockers	90.1	89.1	0.16

Abbreviations: COTH= Council of Teaching Hospitals, ICU=intensive care unit, DVT=deep vein thrombosis

[a] Hospitals included are those with at least one spine surgery during the study period (July 2007–September 2009).

[b] Significant difference between designated hospitals and other hospitals based on a chi-square test or Satterthwaite t-test ($P<.05$).

[c] Structural characteristics were derived from the 2008 American Hospital Association file. [5]

[d] Having an ICU was a requirement for designated hospitals; however, not all reported having an ICU to the AHA survey.

[e] Patient experience measures were derived from the 2008 H-CAHPS survey data available on the Medicare Hospital Compare website.[17]

[f] Surgical quality of care measures were derived from the 2008 Surgical Care Improvement Project (SCIP) data available on the Medicare Hospital Compare website.[17]

Table 3

Characteristics of Patients with Cervical Simple Fusion, Lumbar Simple Fusion, or Lumbar Discectomy/Decompression Performed in Designated Hospitals and Other Hospitals, July 2007–September 2009

Patient Characteristic	Cervical Simple Fusion				Lumbar Simple Fusion				Lumbar Discectomy/Decompression			
	Designated Hospitals N=12,349		Other Hospitals N=16,946		Designated Hospitals N=11,284		Other Hospitals N=15,930		Designated Hospitals N=13,588		Other Hospitals N=15,323	
	N	%	N	%	N	%	N	%	N	%	N	%
Age												
18–44	3,578	29.0	4,730	27.9	**3.040**	**26.9**	**4,451**	**27.9**	4,810	35.4	5,334	34.8
45–54	5,332	43.2	7,276	42.9	**3,582**	**31.7**	**5,323**	**33.4**	4,006	29.5	4,554	29.7
55–64	3,439	27.9	4,940	29.2	**4,662**	**41.3**	**6,156**	**38.6**	4,772	35.1	5,435	35.5
Gender (% Male)	5,621	45.5	7,700	45.4	4,755	42.1	6,860	43.1	7,707	56.7	8,540	55.7
Co-morbidities[b]												
Hypertension	4,470	36.2	6,163	36.4	4,834	42.8	6,909	43.4	**4,845**	**35.7**	**5,669**	**37.0**
Diabetes	1,392	11.3	1,999	11.8	1,405	12.5	2,082	13.1	1,540	11.3	1,832	12.0
Vascular Disease	376	3.0	462	2.7	**775**	**6.9**	**942**	**5.9**	574	4.2	583	3.8
Chronic Atherosclerosis	640	5.2	872	5.2	733	6.5	1,027	6.5	775	5.7	846	5.5

[a] Rates in bold represent a significant difference between designated hospitals and other hospitals based on a chi-square test ($P<.05$).

[b] Selected co-morbidities are shown in this table. A complete set of all 26 co-morbidities included in the models is provided in the Appendix.

Table 4

Unadjusted Rates and Adjusted Odds Ratios for Selected Complication and Readmission Rates following Cervical Simple Fusion, Lumbar Simple Fusion, and Lumbar Discectomy/Decompression Performed in Designated Hospitals and Other Hospitals, July 2007–September 2009

	Cervical Simple Fusion					Lumbar Simple Fusion					Lumbar Discectomy/Decompression				
	Designated Hospitals N=12,349		Other Hospitals N=16,946		Odds Ratio (95% CI) [a]	Designated Hospitals N=11,284		Other Hospitals N=15,930		Odds Ratio (95% CI) [a]	Designated Hospitals N=13,588		Other Hospitals N=15,323		Odds Ratio (95% CI) [a]
Outcome Category	N	Rate (%)	N	Rate (%)		N	Rate (%)	N	Rate (%)		N	Rate (%)	N	Rate (%)	
Any of 7 Complications	157	1.27	234	1.38	0.90 (0.72–1.12)	465	4.12	659	4.14	0.98 (0.85–1.13)	439	3.23	524	3.42	0.95 (0.82–1.07) [b]
Acute myocardial infarction (within 7 days of admission)	6	0.05	7	0.04	1.19 (0.40–3.57) [b]	12	0.11	19	0.12	0.84 (0.39–1.78) [b]	9	0.07	8	0.05	1.25 (0.48–3.27) [b]
Pneumonia (within 7 days of admission)	32	0.26	42	0.25	1.02 (0.63–1.67)	62	0.55	109	0.68	0.80 (0.59–1.09)	24	0.18	31	0.20	0.86 (0.49–1.49)[b]
Sepsis/Septicemia (within 7 days of admission)	17	0.14	23	0.14	1.02 (0.55–1.91) [b]	57	0.51	84	0.53	0.90 (0.62–1.31)	17	0.13	26	0.17	0.75 (0.42–1.33) [b]
Pulmonary embolism (within 30 days of admission)	20	0.16	20	0.12	1.37 (0.70–2.67) [b]	55	0.49	55	0.35	1.37 (0.90–2.09)	20	0.15	29	0.19	0.77 (0.44–1.35) [b]
In-hospital mortality (during index stay)	5	0.04	3	0.02	2.32 (0.56 – 9.50) [b]	4	0.04	10	0.06	0.55 (0.17–1.79) [b]	2	0.01	6	0.04	0.37 (0.08–1.75) [b]
Wound complications (within 30 days of admission)	31	0.25	52	0.31	0.80 (0.52–1.25)	174	1.54	217	1.36	1.12 (0.90–1.40)	130	0.96	142	0.93	1.04 (0.82–1.32)
Repeat spine surgery (within 90 days of admission)	65	0.53	105	0.62	0.84 (0.60–1.20)	132	1.17	225	1.41	0.83 (0.63–1.09)	260	1.91	312	2.04	0.93 (0.77–1.12)
Any Readmission (within 30 days of discharge)	287	2.32	381	2.25	1.03 (0.87–1.21)	590	5.23	817	5.13	1.01 (0.89–1.13)	483	3.55	591	3.86	0.91 (0.79–1.04)

[a] For each complication, this represents the odds ratio comparing designated hospitals to other hospitals.

[b] For this outcome, odds ratios and confidence intervals are based on a model with fewer covariates because initially the model did not converge. See Appendix for details.

Table 5

90-Day Medical Costs and Index Hospitalization Costs for Designated Hospitals and Other Hospitals for Cervical Simple Fusion, Lumbar Simple Fusion, and Lumbar Discectomy/Decompression, July 2007–September 2009

Cost Category	Cervical Simple Fusion			Lumbar Simple Fusion			Lumbar Discectomy/Decompression		
	Designated Hospitals N=12,342[b]	Other Hospitals N=16,937[b]	Adjusted % Higher Costs at Designated vs. Other Hospitals (95% CI) *	Designated Hospitals N=11,279[b]	Other Hospitals N=15,916[b]	Adjusted % Higher Costs at Designated vs. Other Hospitals (95% CI) *	Designated Hospitals N=13,585[b]	Other Hospitals N=15,314[b]	% Difference between Designated and Other Hospitals (95% CI) *
	Mean unadjusted costs $ (SD)			Mean unadjusted costs $ (SD)			Mean unadjusted costs $ (SD)		
Total medical costs during 90 days following admission date[a]	26,187 (16,762)	26,548 (17,959)	3.0% (0.3%–6.4%)	44,919 (28,737)	45,669 (30,991)	1.8% (−1.6%–5.2%)	14,528 (10,324)	14,929 (13,088)	−0.3% (−3.6%–3.1%)
Medical costs during index hospitalization	22,945 (11,110)	23,063 (13,354)	1.1% (−3.3%–5.5%)	40,010 (24,496)	40,753 (26,803)	2.9% (−1.8%–7.7%)	11,382 (5,180)	11,562 (11,382)	2.3% (−1.6%–6.2%)

[a] Medical costs include the index hospitalization and all other medical costs in the 90 days following the admission date of the index hospitalization.

[b] The sample size differs from Table 4 because patients who died in the 90 days after surgery were excluded from these cost analyses as were patients for whom the “allowed cost” fields were zero for all their claims

* The percentage represents the adjusted difference in costs at designated hospitals compared to other hospitals. For example, 3.0% means costs at designated hospitals were 3.0 percentage points higher than at other hospitals. Models included age, gender, and presence of 26 different comorbidities.