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Clinical Study

Incidence and considerations of 90-day readmissions following posterior lumbar fusion

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Abstract

BACKGROUND CONTEXT: Posterior lumbar fusion (PLF) is a commonly performed procedure. The evolution of bundled payment plans is beginning to require physicians to more closely consider patient outcomes up to 90 days after an operation. Current quality metrics and other databases often consider only 30 postoperative days. The relatively new Healthcare Cost and Utilization Project Nationwide Readmissions Database (HCUP-NRD) tracks patient-linked hospital admissions data for up to one calendar year.

PURPOSE: To identify readmission rates within 90 days of discharge following PLF and to put this in context of 30 day readmission and baseline readmission rates.

STUDY DESIGN: Retrospective study of patients in the HCUP-NRD.

PATIENT SAMPLE: Any patient undergoing PLF performed in the first 9 months of 2013 were identified in the HCUP-NRD.

OUTCOME MEASURES: Readmission patterns up to a full calendar year after discharge.

METHODS: PLFs performed in the first 9 months of 2013 were identified in the HCUP-NRD. Patient demographics and readmissions were tracked for 90 days after discharge. To estimate the average admission rate in an untreated population, the average daily admission rate in the last quarter of the year was calculated for a subset of PLF patients who had their operation in the first quarter of the year. This study was deemed exempt by the institution's Human Investigation Committee.

RESULTS: Of 26,727 PLFs, 1,580 patients (5.91%) were readmitted within 30 days of discharge and 2,603 patients (9.74%) were readmitted within 90 days of discharge. Of all readmissions within 90 days, 54.56% occurred in the first 30 days. However, if only counting readmissions above the baseline admission rate of a matched population from the 4th quarter of the year (0.08% of population/day), 89.78% of 90 day readmissions occurred within the first 30 days.

CONCLUSIONS: The current study delineates readmission rates after PLF and puts this in the context of 30-day readmission rates and baseline readmission rates for those undergoing PLF. These results are important for patient counseling, planning, and preparing for potential bundled payments in spine surgery.

Keywords: Bundled payments; Posterior lumbar fusion; Readmission; Nationwide Readmission Database; 30 Day Readmissions; 90 Day Readmissions.

Introduction

Over the past years, there has been a clear emphasis on tracking and optimizing quality metrics after surgeries such as posterior lumbar fusions (PLF) [1]. One such metric is 30-day postdischarge readmissions [2–4]. In fact, there has been a move to consider penalizing hospitals that are

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outliers for such defined metrics [5]. The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) has been extensively used to facilitate tracking, analyzing, and predicting risks for 30 day postoperative outcomes following lumbar fusions [6,7].

In further efforts to make health care more affordable, Medicare and Medicaid reimbursements for procedures such as total joints are moving toward bundled payments [8]. In such models, a lump sum of money is provided to care for patients for a 90-day time period deemed an "episode of care," with no additional financial compensation for any complications that occur within that timeframe. Though the amount of a bundled payment varies with the average cost of a procedure, the length of an episode of care is fixed.

PLF is an established and effective spine procedure used to treat lumbar pathology that has often been studied and associated with good outcomes and relatively low morbidity [10]. As the population continues to age, the demand for spinal fusion procedures for degenerative conditions is only expected to increase [11]. However, owing to the high frequency and costs of PLFs, this is expected to be a continued target of cost reduction initiatives. Should payment of spine procedures go in the direction of bundled payments, it may be important to better understand the treatment needs of patients undergoing PLF over longer periods of follow-up than the 30-day period such as available in NSQIP [12,13].

The current study is designed to use the relatively newly available Healthcare Cost and Utilization Project Nationwide Readmissions Database (HCUP-NRD) to characterize readmissions over the 90 day postoperative period following discharge [14]. Furthermore, the readmission differences between 30 and 90 days are to be compared and considered in light of baseline readmission rates that might be expected for the patient populations undergoing this procedure.

Materials and methods

Data source and patient population

The 2013 HCUP-NRD is a database that draws from the HCUP State Inpatient Databases and included 21 states spread across the United States, over 2,000 community and academic hospitals, and over 14,000,000 discharges. Patient discharges include basic demographics, diagnosis and procedure codes, and basic hospital information. Most importantly for the current study, patients are assigned unique linkage numbers that remain consistent through different hospital admissions, including admissions to different participating centers so specific patient admissions can be tracked for up to a calendar year.

Any patient age 18 or older undergoing a PLF with or without an interbody fusion was identified by International Statistical Classification of Disease-9 Procedure code 81.08 as were their subsequent admissions within 90 days of discharge. Patients undergoing procedures in October, November, and December were excluded as they could not be followed for a full 90 days.

Patient demographics such as age, gender, and median time to readmissions were collected as discrete variables. A Charlson comorbidity index (CCI) and Elixhauser score were calculated from International Statistical Classification of Disease-9 diagnosis codes present at discharge. Demographics were assessed for the primary admission and first three readmissions within 90 days.

Readmission rate

Readmission rates were calculated as a daily percent of the sample population. This is calculated such that 0% would be no readmissions and 100% would represent the whole sample population being readmitted on the same day. This was followed until 90 days and the percent of those admissions that would have occurred within the first 30 days was calculated for comparison purposes.

In order to determine a baseline admission rate in a matched population, admissions for patients who had a procedure done in the first quarter of the year (Q1) were identified and followed throughout the year. The total number of admissions in the fourth quarter of the year (Q4) for that subpopulation was divided by the total Q1 sample size and then by 92 days to determine the average percentage of the Q1 sample that was admitted each day in Q4.

Though one can question if the readmission rate had stabilized by 30 days, this calculation made the assumption that the readmission rate, surgical or not, for this matched population would have stabilized by half a year later. Currently databases provide data for events occurring within 30 days of operation so, to our knowledge, this is the best way to estimate a baseline admission rate. To confirm that this assumption appeared justified, the average daily admission rate was plotted against an adjusted daily admission per postdischarge day for Q1 PLF population. The daily admission rate was adjusted for any patients leaving the sampling time. Average admission rates and standard deviations were calculated every 5 days to assess any statistical difference between observed and baseline readmissions.

Using the calculated baseline readmission rated in the method described above, the 90-day readmissions were reassessed with the baseline readmission rate in mind. The percent of 90-day readmissions that occurred within the first 30 days was recalculated, subtracting the baseline readmission rate from the observed daily readmission rates.

Because the data is deidentified, this study was deemed exempt by our institution review board. Stata IC 13.0 (StataCorp, College Station, TX) was used for data management and Excel 2013 (Microsoft, Redmond, WA) was used for graphics.

Table 1
Demographics and comorbidities

	Index	1st Readmission	2nd Readmission	3rd Readmission
Total N (% of Total or previous)†	26,727 (100.00%)	2,603 (9.74%)	425 (16.33%)	73 (17.18%)
Median time to readmission and IQR (Days)	N/A	21 (8–47)	46 (27–69)	58 (45–75)
Female gender (% of Current admission)	14,883 (55.69%)	1,491 (57.28%)	253 (59.53%)	47 (64.38%)
Male gender (% of Current admission)	11,844 (44.31%)	1,112 (42.72%)	172 (40.47%)	26 (35.62%)
Age range (% of Total or previous)†				
18–19	41 (0.15%)	*	*	*
20–29	618 (2.31%)	38 (6.15%)	*	*
30–39	1,991 (7.45%)	146 (7.33%)	21 (14.38%)	*
40–49	4,021 (15.04%)	300 (7.46%)	45 (15.00%)	*
50–59	6,294 (23.55%)	510 (8.10%)	77 (15.10%)	18 (23.38%)
60–69	7,643 (28.60%)	781 (10.22%)	149 (19.08%)	19 (12.75%)
70–79	5,075 (18.99%)	631 (12.43%)	99 (15.69%)	15 (15.15%)
80–89	1,026 (3.84%)	189 (7.3%)	28 (1.48%)	*
90+	18 (0.07%)	*	*	*
CCI at index visit (% of total or previous)†				
0–3	25,655 (95.99%)	2,380 (9.28%)	371 (15.59%)	59 (15.90%)
4+	1,072 (4.01%)	223 (20.80%)	54 (0.20%, 24.22%)	14 (25.93%)
Elixhauser at index Visit (% of total or previous)†				
0–3	25,655 (95.99%)	2,380 (9.28%)	371 (15.59%)	59 (15.90%)
4–6	1,058 (3.96%)	221 (20.89%)	54 (24.43%)	14 (25.93%)
7–9	14 (0.05%)	*	*	*

* Groups with less than 10 patients cannot be reported per HCUP user agreement.
† % of total population for index visits or % of previous admission for readmissions within 90 days.CCI = Charlson's Comorbidity IndexUnderlined range contains the median.

Results

Total 30 vs 90 day readmissions

Of 26,727 patients undergoing PLF, 1,580 patients (5.91% of the study population) were readmitted within 30 days of discharge and 2,603 patients (9.74%) were readmitted within 90 days of discharge. Of those patients readmitted within 90 days, 60.70% occurred in the first 30 days. More information about the demographics and comorbidities of those readmitted one, two, or three times after PLF can be found in Table 1.

Rate of readmissions from day 0 to 90 days postdischarge were then graphed by postdischarge day (Fig. 1). Of the 3,124 readmissions, including multiple readmissions that occurred within 90 days postdischarge, 1,705 (54.58%) occurred within the first 30 days.

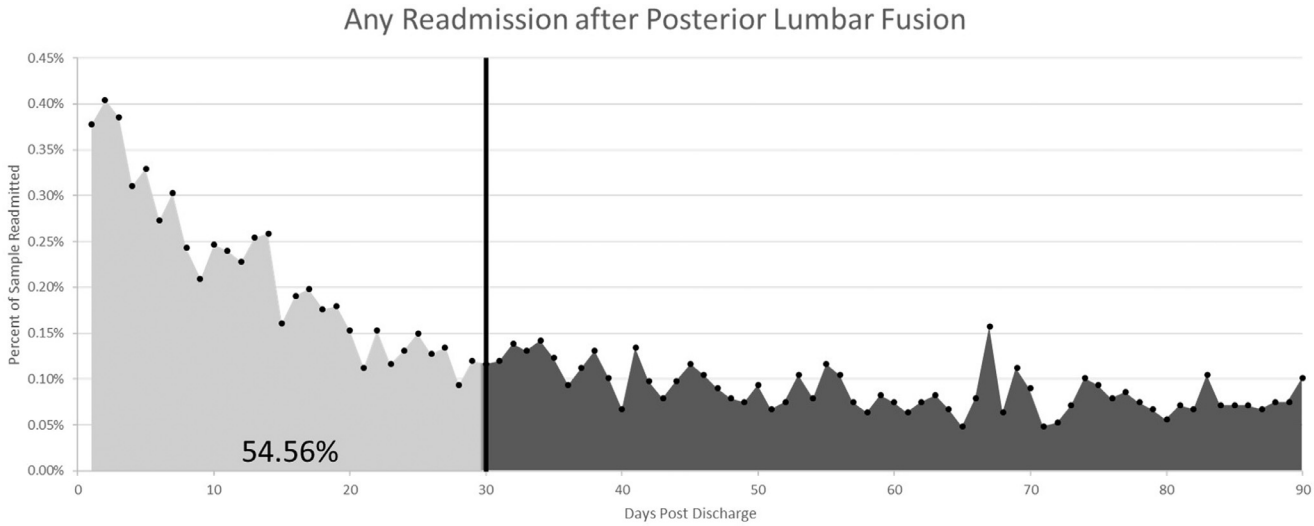

Fig. 1. All admissions following all posterior lumbar fusions with day post-discharge after index admission shown on the x axis and percentage of sample shown on the y axis. Admissions within the first 30 days post-discharge are to the left of the vertical line and shaded gray. 54.58% of all 90-day admission occurred within the first 30 days. The rate of readmissions seems to visually plateau within 90 days.

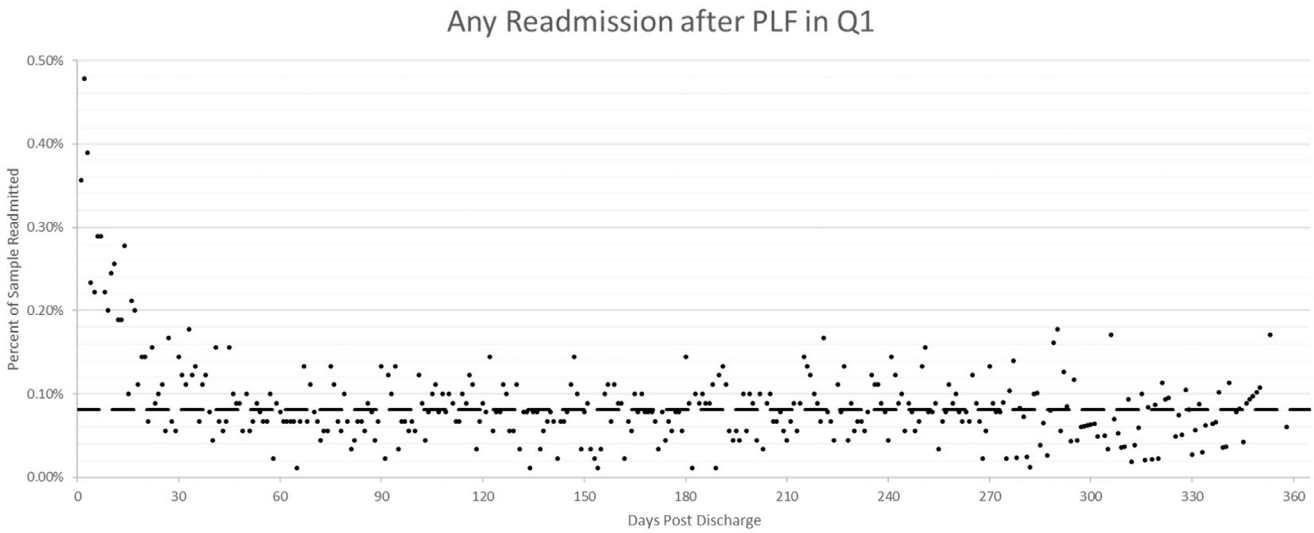

Fig. 2. All admissions following posterior lumbar fusions in Q1 with day post-discharge after index admission shown on the x axis and percentage of sample shown on the y axis. The horizontal dashed line indicates 0.081% of the Q1 sample admitted, on average, per day in Q4. Of note, the projected baseline readmission seems to remain relatively constant for the full duration of observation, not only within the first 90 days seen in Fig. 1.

Baseline admission rate

There were 8,993 documented PLFs in the HCUP-NRD in the 1st quarter (Q1). The readmission rate is graphed relative to postdischarge day followed to up to a year (Fig. 2). By the 4th quarter (Q4), this subpopulation had 672 admissions, which averages to 7.30 admissions per day or 0.081% of the Q1 population per day.

Adjusted 30 vs 90 day readmissions

The graph of 90-day readmissions from Fig. 1 was repeated now adjusting for the baseline admission rate calculated in the section above (Fig. 3). If only counting readmission above the baseline admission rate of a matched population for the 4th quarter of the year (0.08% of the population/day), 89.78% occurred within the first 30 days. In fact, by postdischarge day 40, the moving average readmission rates approximated the baseline admission rate.

Discussion

Unplanned readmissions after surgeries such as PLF are important markers of quality of care. To that point, 90-day readmissions are expected to receive increased attention as bundled payments are considered for spine surgeries as has been done for joint arthroplasties [9]. Previous studies regarding readmissions for spine surgery

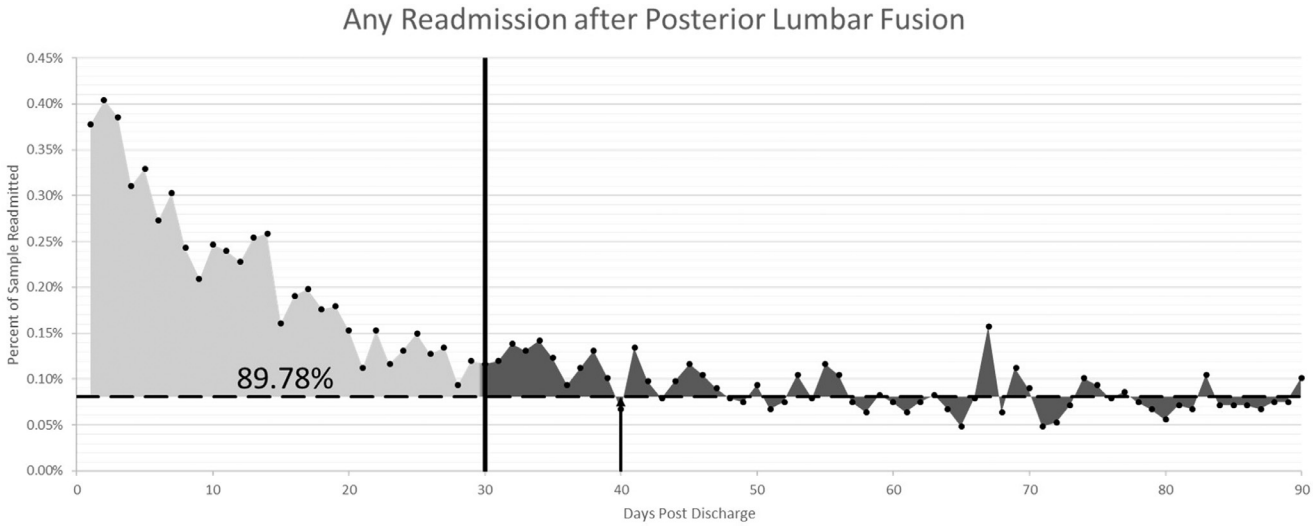

Fig. 3. All admissions following posterior lumbar fusions with days post discharge after index admission shown on the x axis and percentage of sample shown on the y axis. The difference between baseline admission rate and observed admissions shaded gray. 89.78% of all 90-day admissions over the baseline admission rate occurred within the first 30 days. 5-day admission patterns were not statistically different from baseline admission rates at 40 days (arrow).

usually have a 30-day postoperative follow-up period and thus do not cover the full 90-day window [6,7]. The HCUP-NRD has provided a means to investigate admissions on a longer scale through tracking patient admissions between all participating centers for up to a full calendar year, allowing for the most accurate means of currently tracking readmissions. The purpose of the current study was to evaluate the incidence of readmissions within this longer follow-up time for patients undergoing PLF.

The 30-day readmission rate of 5.91% was similar to previously reported NSQIP data (5.6%) [15]. However, it is notable that the total number of admissions almost doubled after following them out to 90 days (9.74%). On first pass, this seems to suggest that the readmission rates may still be rising around the 30-day postdischarge window. However, it was visually noted that the readmission rate seemed to plateau around that point (Fig. 1). Statistically, the change in the 5-day average readmission rates also decreased and fluctuated less around the 1-month mark. The difference between the total number of readmissions after 30 and 90 days seemed to be related to the fact that a low baseline level of readmissions continued through the 30-day postdischarge period for up to a full year (Fig. 2).

The above finding led this study down the path of further evaluating baseline readmissions. In order to find a matched cohort, readmissions of a subset of the patients who had surgery in the first quarter of the year was evaluated in the final quarter of the year. The admissions documented in the HCUP-NRD indicated that, on average, 0.081% of the sample population is admitted daily 6 months after their index procedure. This baseline rate is an estimate of how often this cohort is hospitalized for reasons not related to the PLF. Though this rate is small, it accounts for most admissions after 30 days postdischarge. As opposed to only 54.58% of the 90-day readmissions occurring in the first 30 days if not taking a baseline readmission rate into account, this proportion increased to 89.78% of the 90-day readmissions occurring in the first 30 days if the calculated baseline readmission rate was subtracted out. The difference of average rate of readmission across 5 days and the baseline readmission rate became statistically insignificant after day 40, quantitatively supporting our previous observations regarding a plateau in the readmission rates (Fig. 3).

Another means of estimating baseline hospital admission rates include the National Health Interview Survey. Though it has a much larger sample size, it does not contain details to form a matched population. Additionally, it underestimates the amount of hospital admission as the National Health Interview Survey only documents up to 3 admissions per individual for the year [16].

Regardless of the method used to estimate a baseline admission rate, it is important to consider it when determining the length of an episode of care to avoid overestimating the effect a procedure has on readmissions. Of course, this does not negate the ideal of incorporating all admissions in the calculation of the value of a bundled payment, but underscores that the longer the episode of care, the more the baseline readmissions contribute to the cost of care.

There are limitations to the current study. As with any large database, there are inherent limitations to data collected. As an administrative database, the HCUP-NRD does not contain spine-specific measures, such as presence or absence of an interbody, and the data can be inaccurate for a specific procedure [17]. Additionally the number of readmissions noted in the database is an underestimate of the actual incidence as there would be loss of follow-up if patients were readmitted to centers that did not participate in the HCUP-NRD. The estimate this database provides is more accurate than single and small multiple institutional studies as each patient has a unique linkage number that tracks their admissions between a larger amount of hospitals. Finally, the relation between fusion and readmissions could not be accurately determined from diagnosis codes without a full clinical picture. However, the primary data collected was admissions, a binary variable that seems more reliable to work from. By using such data, there was power to study the relatively rare events of readmissions at a national level.

As health care moves more toward bundled payments, it is important to investigate admission rates within the potential follow-up windows. The relatively new HCUP-NRD tracks patients for all admissions within a calendar year, allowing investigation beyond the current 30-day postoperative follow-up found in the commonly used NSQIP database. The data shows that approximately half of admissions within 90 days after PLF occur within the first 30 days. However, it is important to note that much of this may be attributed to baseline admission rates. Areas of future studies include determining aspects of care and costs during these longer periods of postoperative care.

References

[1] Makino T, Kaito T, Fujiwara H, Honda H, Sakai Y, Takenaka S, et al. Risk factors for poor patient-reported quality of life outcomes after posterior lumbar interbody fusion: an analysis of two-year follow-up. Spine 2017;42(19):1502–10.

[2] Adogwa O, Elsamadicy AA, Han JL, Karikari IO, Cheng J, Bagley CA. 30-day re-admission after spine surgery: an analysis of 1400 consecutive spine surgery patients. Spine 2016;42(7):520–4.

[3] Elsamadicy AA, Adogwa O, Vuong VD, Mehta AI, Vasques RA, Cheng J, et al. Association of intra-operative blood transfusions on post-operative complications, 30-day readmission rates, and one-year patient reported outcomes. Spine 2016;42(8):610–5.

[4] Missios S, Bekelis K. Outpatient continuity of care and 30-day readmission after spine surgery. Spine J 2016;16(11):1309–14.

[5] Services CfMM. Readmissions reduction program. 2016. https://wwwcms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/readmissions-reduction-program.html; 2017.

[6] Basques BA, Diaz-Collado PJ, Geddes BJ, Samuel AM, Lukasiewicz AM, Webb ML, et al. Primary and revision posterior lumbar fusion have similar short-term complication rates. Spine 2016;41(2):E101–6.

[7] Basques BA, Anandasivam NS, Webb ML, Samuel AM, Lukasiewicz AM, Bohl DD, et al. Risk factors for blood transfusion with primary posterior lumbar fusion. Spine 2015;40(22):1792–7.

[8] Bushnell BD. Bundled payments in orthopedic surgery. Orthopedics 2015;38(2):128–35.
[9] Nedza SM, Fry DE, DesHarnais S, Spencer E, Yep P. Emergency department visits following joint replacement surgery in an era of mandatory bundled payments. Acad Emerg Med 2016;24(2):236–45.
[10] Weinstein JN, Tosteson TD, Lurie JD, Tosteson AN, Blood E, Hanscom B, et al. Surgical versus nonsurgical therapy for lumbar spinal stenosis. New Engl J Med 2008;358(8):794–810.
[11] Goldstein CL, Macwan K, Sundararajan K, Rampersaud YR. Comparative outcomes of minimally invasive surgery for posterior lumbar fusion: a systematic review. Clin Orthop Rel Res 2014;472(6):1727–37.
[12] Ugiliweneza B, Kong M, Nosova K, Huang KT, Babu R, Lad SP, et al. Spinal surgery: variations in health care costs and implications for episode-based bundled payments. Spine 2014;39(15):1235–42.
[13] Virk SS, Phillips FM, Khan SN. Reimbursement related to a 90-day episode of care for a one or two-level anterior cervical discectomy and fusion. J Bone Joint Surg 2016;98(16):1378–84.
[14] NRD Overview. Healthcare cost and utilization project (HCUP). Rockville, MD: Agency for Healthcare Research and Quality; December 2016. www.hcup-us.ahrq.gov/nrdoverview.jsp.
[15] Basques BA, Ibe I, Samuel AM, Lukasiewicz AM, Webb ML, Bohl DD, et al. Predicting postoperative morbidity and readmission for revision posterior lumbar fusion. Clin Spine Surg 2016;30(6):E770–5.
[16] Statistics NCfH. National health interview survey, 2013. In: Statistics NCfH, ed. Hyattsville, Maryland 2013.
[17] Gologorsky Y, Knightly JJ, Chi JH, Groff MW. The nationwide inpatient sample database does not accurately reflect surgical indications for fusion. J Neurosurg Spine 2014;21(6):984–93.