Hospital charges associated with “never events”: comparison of anterior cervical discectomy and fusion, posterior lumbar interbody fusion, and lumbar laminectomy to total joint arthroplasty

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OBJECTIVE Beginning in 2008, the Centers for Medicare and Medicaid Service (CMS) determined that certain hospital-acquired adverse events such as surgical site infection (SSI) following spine surgery should never occur. The following year, they expanded the ruling to include deep vein thrombosis (DVT) and pulmonary embolism (PE) following total joint arthroplasty. Due to their ruling that “never events” are not the payers’ responsibility, CMS insists that the costs of managing these complications be borne by hospitals and health care providers, rather than billings to health care payers for additional care required in their management. Data comparing the expected costs of such adverse events in patients undergoing spine and orthopedic surgery have not previously been reported.

METHODS The California State Inpatient Database (CA-SID) from 2008 to 2009 was used for the analysis. All patients with primary procedure codes indicating anterior cervical discectomy and fusion (ACDF), posterior lumbar interbody fusion (PLIF), lumbar laminectomy (LL), total knee replacement (TKR), and total hip replacement (THR) were analyzed. Patients with diagnostic and/or treatment codes for DVT, PE, and SSI were separated from patients without these complication codes. Patients with more than 1 primary procedure code or more than 1 complication code were excluded. Median charges for treatment from primary surgery through 3 months postoperatively were calculated.

RESULTS The incidence of the examined adverse events was lowest for ACDF (0.6% DVT, 0.1% PE, and 0.03% SSI) and highest for TKA (1.3% DVT, 0.3% PE, 0.6% SSI). Median inpatient charges for uncomplicated LL was \$51,817, compared with \$73,432 for ACDF, \$143,601 for PLIF, \$74,459 for THR, and \$70,116 for TKR. Charges for patients with DVT ranged from \$108,387 for TKR (1.5 times greater than index) to \$313,536 for ACDF (4.3 times greater than index). Charges for patients with PE ranged from \$127,958 for TKR (1.8 times greater than index) to \$246,637 for PLIF (1.7 times greater than index). Charges for patients with SSI ranged from \$168,964 for TKR (2.4 times greater than index) to \$385,753 for PLIF (2.7 times greater than index).

CONCLUSIONS Although incidence rates are low, adverse events of spinal procedures substantially increase the cost of care. Charges for patients experiencing DVT, PE, and SSI increased in this study by factors ranging from 1.8 to 4.3 times those for patients without such complications across 5 common spinal and orthopedic procedures. Cost projections by health care providers will need to incorporate expected costs of added care for patients experiencing such complications, assuming that the cost burden of such events continues to shift from payers to providers.

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KEY WORDS never event; adverse event; complication; cost; hospital charge; infection; deep vein thrombosis; anterior cervical discectomy and fusion; lumbar

ABBREVIATIONS ACDF = anterior cervical discectomy and fusion; CA-SID = California State Inpatient Database; CMS = Centers for Medicare and Medicaid Service; DVT = deep vein thrombosis; HCUP = Healthcare Cost and Utilization Project; ICD-9-CM = *International Classification of Diseases, Ninth Revision, Clinical Modification*; LL = lumbar laminectomy; PE = pulmonary embolism; PLIF = posterior lumbar interbody fusion; SSI = surgical site infection; THR = total hip replacement; TKR = total knee replacement.

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ON October 1, 2007, the Centers for Medicare and Medicaid Services (CMS) required all hospitals to report both primary and secondary diagnoses when submitting discharge claims. By July 31, 2008, CMS designated 8 specific hospital-acquired adverse events as “never events,” which should thus never occur following spinal surgery (<https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/index.html>). Three months later, reimbursement restrictions were added for catheter-associated urinary tract infections, certain surgical site infections (SSIs), and manifestations of poor glycemic control.² The following year, CMS expanded the ruling to include deep vein thrombosis (DVT) and pulmonary embolism (PE) following total joint arthroplasty (Fig. 1).^{6,9–11,15} Although CMS has yet to expand the definition of never event to DVT/PE following spinal surgery, new rulings such as the addition of “radiological never events” in 2011 are evidence of the ongoing expansion of the program.

Due to the never event ruling, CMS as well as some private insurers insist that the costs of managing these complications be borne by hospitals and health care providers, rather than billings to health care payers for additional care required in their management.⁹ As payers continue to shift financial responsibility for these events to hospital providers through bundled payments and population-based contracting, detailed data are necessary to evaluate the incidence and cost of such adverse events.

Thus far, data regarding the expected costs of never events following surgical procedures have been limited.^{6,8,10,15} In the present study, we used a billing database to compare the relative charges for patients experiencing SSI, DVT, and PE following anterior cervical discectomy and fusion (ACDF), posterior lumbar interbody fusion (PLIF), lumbar laminectomy (LL), total knee replacement (TKR), and total hip replacement (THR).

Methods

Patient Selection

The California State Inpatient Database (CA-SID) from 2008 to 2009 was used for analysis. Determining admissions to hospitals in the state of California using the discharge data from the CA-SID between the years 2008 and 2009 was performed. This database is a subset of the Healthcare Cost and Utilization Project (HCUP) from the Agency for Healthcare Research and Quality.¹⁴ HCUP records statewide inpatient data, ambulatory surgery, and services data, as well as emergency department data. While California reports all 3 through its CA-SID, only inpatient data were used in the analysis.

CA-SID is an all-payer administrative database including 100% of the state’s inpatient discharge records from nonfederal hospitals. Each CA-SID record includes: 1) basic demographic information, including age, sex, race, and primary payer; 2) up to 30 *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis codes; 3) up to 21 ICD-9-CM procedure codes; and 4) outcome information, such as discharge disposition, length of stay, and inpatient charges. This database does not include outpatient charges such as diagnostic studies performed as an outpatient or outpatient physical therapy, nor does it include a breakout of direct versus indirect costs or other detailed analysis of cost assessment.

Diagnoses and procedures were coded using the ICD-9-CM (Table 1). All patients admitted between January 2008 and September 2009 with primary procedure codes indicating ACDF (81.02), PLIF (81.08), LL (03.09), TKR (81.54), and THR (81.51) were identified.

Patients with more than 1 of the examined primary procedure codes were excluded from the final study population with the exception of those with codes for both PLIF and LL, who were subsequently included under the PLIF analysis. Additionally, patients lacking total charge data were excluded from final analyses.

CMS HOSPITAL ACQUIRED CONDITIONS	
The 10 categories of HACs include ² :	
• Foreign Object Retained After Surgery	• Catheter-Associated Urinary Tract Infection (UTI)
• Air Embolism	• Vascular Catheter-Associated Infection
• Blood Incompatibility	• Surgical Site Infection Following:
• Stage III and IV Pressure Ulcers	» Coronary Artery Bypass Graft (CABG) - Mediastinitis
• Falls and Trauma	» Bariatric Surgery
» Fractures	• Laparoscopic Gastric Bypass
» Dislocations	• Gastroenterostomy
» Intracranial Injuries	• Laparoscopic Gastric Restrictive Surgery
» Crushing Injuries	» Orthopedic Procedures
» Burns	• Spine
» Electric Shock	• Neck
• Manifestations of Poor Glycemic Control	• Shoulder
» Diabetic Ketoacidosis	• Elbow
» Nonketotic Hyperosmolar Coma	• Deep Vein Thrombosis (DVT)/
» Hypoglycemic Coma	Pulmonary Embolism (PE)
» Secondary Diabetes with Ketoacidosis	» Total Knee Replacement
» Secondary Diabetes with Hyperosmolarity	» Hip Replacement ²

FIG. 1. CMS hospital-acquired conditions: “never events.” Reproduced with permission from Lembitz and Clarke: *Patient Saf Surg* 3:26, 2009. Creative Commons attribution license 2.0 (<http://creativecommons.org/licenses/by/2.0>). Figure is available in color online only.

Detection of Complication

Patients with no reported complications and those with ICD-9-CM codes in the inpatient hospital record for DVT (453.40, 453.41, 453.42, 453.6), PE (415.11, 415.13), or SSI (996.66, 996.67, V43.64, V43.65) within 3 months postoperatively were selected for cost analysis. Patients with more than 1 complication code were not included for cost analysis.

Cost Analysis

Charges for treatment and subsequent inpatient hospitalization from primary surgery through 3 months postoperatively were calculated in patients with uncomplicated procedures and compared with those complicated with DVT, PE, or SSI. Charges were adjusted for inflation to 2015 US dollars utilizing the Consumer Price Index inflation calculator provided by the Bureau of Labor Statistics.¹¹

Results

A total of 157,431 patients were identified as having 1 index procedure. Of these, 136,371 patients had valid total charges, representing the final study population. There were 15,729 patients with ACDF, 19,706 patients with PLIF, 15,217 patients with LL, 56,467 patients with TKR, and 29,252 patients with THR (Table 1).

In this study population, 130,670 patients did not suffer any of the examined complications up to 3 months postoperatively. In contrast, 1510 patients experienced DVT as the only complication (1.1%), 350 patients had only PE (0.25%), and 591 patients had only SSI (0.43%).

The incidence of the examined adverse events was lowest for ACDF (0.6% DVT, 0.1% PE, and 0.03% SSI; Table 2), compared with PLIF (1.0% DVT, 0.2% PE, and 0.2% SSI), LL (1.4% DVT, 0.2% PE, and 0.2% SSI), TKR (1.3% DVT, 0.3% PE, and 0.6% SSI), and THR (1.0% DVT, 0.2% PE, and 0.6% SSI). The median charges for patients with uncomplicated primary procedures was \$73,432 for ACDF, \$143,601 for PLIF, \$51,817 for LL, \$70,116 for TKR, and \$74,459 for THR.

Charges for patients with DVT ranged from \$108,387 to \$313,536. This represented an increase in charges over uncomplicated procedures of 4.3 times greater (\$313,536) for patients with ACDF, 2.0 times greater (\$284,121) for patients with PLIF, 4.3 times greater (\$222,455) for patients with LL, 1.5 times greater (\$108,387) for patients with TKR, and 1.7 times greater (\$126,951) for patients with THR.

Charges for patients with PE ranged from \$127,958 to \$246,637. This represented an increase in charges over uncomplicated procedures of 2.9 times greater (\$213,088) for patients with ACDF, 1.7 times greater (\$246,637) for patients with PLIF, 3.1 times greater (\$159,566) for patients with LL, 1.8 times greater (\$127,958) for patients with TKR, and 1.9 times greater (\$143,473) for patients with THR.

Charges for patients with SSI ranged from \$168,964 to \$385,753. This represented an increase in charges over uncomplicated procedures of 2.4 times greater (\$172,967) for patients with ACDF, 2.7 times greater (\$385,753) for patients with PLIF, 3.8 times greater (\$196,112) for pa-

TABLE 1. Type and number of surgical procedures and complications

Procedure or Complication	ICD-9-CM Code	Patients w/ Valid Total Charges
Procedure		
ACDF	81.02	15,729
PLIF	81.08	19,706
LL	03.09	15,217
TKR	81.54	56,467
THR	81.51	29,252
Total		136,371
Complication		
DVT	453.40, 453.41, 453.42, 453.6	1510
PE	415.11, 415.13	350
SSI	996.66, 996.67 (V43.64 or V43.65)	591
Total		2451 (1.8%)

tients with LL, 2.4 times greater (\$168,964) for patients with TKR, and 1.7 times greater (\$171,697) for patients with THR.

Discussion

Hospital charges associated with a single complication following spinal surgery are substantial, with an increase in charges ranging from 1.7 to 4.3 times greater than those of patients without a complication. Although CMS has already determined that SSI is a never event following spinal and joint arthroplasty procedures, they have not yet expanded DVT/PE following spinal surgery into the never event category. The results of this study provide data regarding the projected economic repercussions if CMS or private payers determine that DVT/PE fit into their definition of a never event following ACDF, LL, and PLIF.

This investigation revealed that SSI/DVT/PE occurred in 1.8% of all procedures analyzed and resulted in a substantial increase in the cost of care of up to 4.3 times the charges of an uncomplicated case. Additionally, the charges associated with SSI/DVT/PE following spine surgery appear to be even higher than those associated with TKR and THR. To the best of our knowledge, this is the first report analyzing the cost of these specific adverse events following spinal and orthopedic surgery procedures.

The high costs associated with adverse events places a burden on the health care system, and the debate about who should bear the burden of paying for such costs is controversial. As payers continue to shift responsibility for these events to hospitals and physicians through bundled payments and population-based contracting, additional financial stress on hospitals and providers is occurring. Although it is not clear at this time whether this trend will continue, data projecting cost effects are potentially helpful to all entities engaged in health care provision.

A previous investigation similarly attempted to examine the effects of the never event ruling on neurological surgery procedures. Teufack et al.¹⁵ performed a prospective investigation revealing a future reduction in physician and facility reimbursement at a tertiary care center with

TABLE 2. Charges for patients with uncomplicated versus complicated procedures

Complication	ACDF	PLIF	LL	TKR	THR
None					
Patients (%)	15,272 (97.0)	18,778 (95.3)	13,929 (91.5)	54,524 (96.6)	28,167 (96.3)
Median total charges (\$)	73,432	143,601	51,817	70,116	74,459
2015 Inflation adjusted (\$)	80,983	158,368	57,146	77,326	82,116
DVT					
Patients (%)	94 (0.6)	194 (1.0)	215 (1.4)	709 (1.3)	284 (1.0)
Median total charges (× Index)*	\$313,536 (4.3)	\$284,121 (2.0)	\$222,455 (4.3)	\$108,387 (1.5)	\$126,951 (1.7)
2015 Inflation adjusted (\$)	345,779	313,339	245,331	119,533	140,006
PE					
Patients (%)	13 (0.1)	46 (0.2)	37 (0.2)	195 (0.3)	56 (0.2)
Median total charges (× Index)*	\$213,088 (2.9)	\$246,637 (1.7)	\$159,566 (3.1)	\$127,958 (1.8)	\$143,473 (1.9)
2015 Inflation adjusted (\$)	235,001	272,000	175,975	141,117	158,227
SSI					
Patients (%)	<10	31 (0.2)	29 (0.2)	344 (0.6)	180 (0.6)
Median total charges (× Index)*	\$172,967 (2.4)	\$385,753 (2.7)	\$196,112 (3.8)	\$168,964 (2.4)	\$171,697 (2.3)
2015 Inflation adjusted (\$)	190,754	425,422	216,279	186,339	189,354

* Number indicates multiplier of median charge compared to that in an uncomplicated procedure.

up to an 8.9% decrease in reimbursement for physicians due to never events. The concern is a decreased ability to care for complex patients due to economic constraints, further restricting care for those most in need.

An investigation of never events in otolaryngology surgery patients undergoing radical neck dissection found a prevalence of never events ranging from 0.2% to 5.0%. They also revealed that the occurrence of never events was associated with an increase in hospital length of stay of 5.6 days and additional charges of \$49,153 compared with hospitalizations without a never event.⁸ A study of patients following radical cystectomy revealed a never-event rate of 2.42%. Vascular-catheter infections (1.25%) were the most common. Black race and comorbidities increased the likelihood of a never event. The presence of any never event increased the average length of stay by 15 days, total costs by \$37,000, and in-hospital mortality by 5.8%.⁶

Another consideration is the potential disparity between the economic and clinical implications of complications.^{1,5} While this study and others have examined the detrimental economic effects of complications,^{6,8,15} numerous studies have also examined the clinical effects of these complications.^{4,7,12} In many cases, the economic effects of a complication may be substantial, while the clinical effects on final outcome may be limited, such as in the case of DVT following ACDF. Furthermore, the complications examined in this investigation will continue to inevitably occur in some patients and should not be referred to as never events. Withholding reimbursement following the occurrence of a complication must be carefully considered by both payers and caregivers to ensure that financial risks are balanced fairly, especially for institutions taking care of higher risk populations.

This study has several limitations. The retrospective study design may be viewed as a limitation; however, the size and robust nature of the database lend to the strength of the data. Additionally, the CA-SID may not be gener-

alizable to all spinal procedures in the US, as there are large geographic variations in spine surgical procedures and in the use of fusion surgery.^{3,13,14,16} In addition, given the design of this database, it is not possible to include costs associated with outpatient management of complications, such as outpatient antimicrobial therapy, international normalized ratio levels, and physical therapy. This may result in underestimation of the total costs associated with managing the studied complications.

Furthermore, an explanation of why DVT has higher-cost spine procedures compared with arthroplasty procedures is not available with this analysis, although increased vigilance by spine surgeons for bleeding complications such as epidural hematomas that may require prolonged hospitalization or placement of inferior vena cava filters provides a possible explanation. Furthermore, why SSI was comparatively costly for patients with LL or why DVT costs more than PE in patients undergoing spine surgery remains unanswered with the current analysis. One possible explanation for SSI costs would be wound vac therapy, which may be used more commonly for lumbar spine wounds compared with cervical or extremity wounds. More specific analysis of the variability between charges associated with adverse events across procedures would require a more detailed clinical database. HCUP, which provided data for this investigation, collects overall hospital charges as reported by the hospitals themselves to the collecting agency without a breakdown of diagnosis-related group- and current procedural terminology-based fees or direct versus indirect costs.

In addition to these limitations, nearly 15% of cases were excluded from the analysis due to lack of total charge information. This is at least partly attributable to patient admissions to Kaiser Permanente hospitals where the charges are not required to be submitted for database collection. We also did not assess other never events, such as falls, medication errors, and wrong site surgery.

Conclusions

Although incidence rates of SSI, DVT, and PE are low, they increase the cost of care substantially. Charges for patients experiencing DVT, PE, and SSI in association with spinal procedures increased by up to 4.3 times. Cost projections by health care providers will need to incorporate expected costs of added care for patients experiencing such complications, assuming that the risk burden of such events shifts from payers to providers. Concerns regarding the accuracy and completeness of inpatient billing data are important limitations to investigations such as this, and also to reimbursement decisions based on billing-derived complication data.

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Disclosures

Dr. Hart is a consultant for DePuy Synthes, Globus, and Medtronic. He receives royalties, is a board member, receives honoraria, and is on the speakers bureau for SeaSpine, DePuy Synthes, CSRS, ISSLS, and ISSG. He also is a patent holder with OHSU, and owns stock in Spine Connect. Dr. Daniels is a consultant for Stryker, Globus, DePuy, and Osseus, and is a patent holder with Quad Rod, Inc.

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