Incidence, Predictors, and Postoperative Complications of Blood Transfusion in Thoracic and Lumbar Fusion Surgery: An Analysis of 13,695 Patients from the American College of Surgeons National Surgical Quality Improvement Program Database

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Abstract

Study Design   Retrospective cohort study.

Objective   To identify predictive factors for blood transfusion and associated complications in lumbar and thoracic fusion surgeries.

Methods   The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients who underwent lumbar or thoracic fusion from 2010 to 2013. Multivariate analysis was used to determine predictive factors and postoperative complications associated with transfusion.

Results   Out of 13,695 patients, 13,170 had lumbar fusion and 525 had thoracic fusion. The prevalence of transfusion was 31.8% for thoracic and 17.0% for lumbar fusion. The multivariate analysis showed that age between 50 and 60, age between 61 and 70, age > 70, dyspnea, American Society of Anesthesiologists class 3, bleeding disease, multilevel surgery, extended surgical time, return to operation room, and higher preoperative blood urea nitrogen (BUN) were predictors of blood transfusion for lumbar fusion. Multilevel surgery, preoperative BUN, and extended surgical time were predictors of transfusion for thoracic fusion. Patients receiving transfusions who underwent lumbar fusion were more likely to develop wound infection, venous thromboembolism, pulmonary embolism, and myocardial infarction and had longer hospital stay. Patients receiving transfusions who underwent thoracic fusion were more likely to have extended hospital stay.

Keywords
► blood transfusion
► lumbar fusion
► thoracic fusion
► spine surgery
► neurosurgery
► NSQIP

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Conclusion   This study characterizes incidence, predictors, and postoperative complications associated with blood transfusion in thoracic and lumbar fusion. Pre- and postoperative planning for patients deemed to be at high risk of requiring blood transfusion might reduce postoperative complications in this population.

Introduction

Spine surgery procedures have been increasing in the United States over the past few years. Spinal fusion (arthrodesis) is one of the most common surgical procedures used to treat back pain and degenerative disease, and it can be performed in all regions of the spine (e.g., cervical, thoracic, or lumbar).[1] This complex surgical procedure is achieved via an anterior or posterior approach and like any surgical procedure carries the potential risk for complications.[2,3] As such, the risk of blood transfusion, although always present in surgical intervention, is especially high in spine surgeries. The incidence of blood product transfusion postoperatively has been estimated to be ~30% in all types of spine fusion surgeries,[4] and hemorrhage rates were reported to be as high as 50 to 80% in adult spine surgery.[2] In addition, patients receiving a blood transfusion have also been found to have higher rates of surgical site infection.[5–7]

Although the rate of blood transfusions is relatively high in spine surgery, the literature on this topic remains sparse, and little is known with regards to possible predictive factors of transfusion requirements. A recent study reported that 1 of 6 patients would likely require a transfusion following primary lumbar fusion procedures. Comorbidities, age, and complexity of procedure were found to be predictors for transfusion.[8] This study also showed that postoperative complications were higher in patients who received a transfusion.

Therefore, the aim of the present study was to (1) investigate the prevalence of blood transfusion in all thoracic and lumbar spine fusion surgeries, (2) determine predictors of transfusion requirements, and (3) investigate the association between blood transfusion and postoperative complications (with 30 days). We hypothesized that patients undergoing thoracic fusion will have a higher risk of requiring a blood transfusion and that patients who received a blood transfusion will be more likely to develop postoperative complications.

Materials and Methods

This study received an exemption by the institutional review board of the McGill University Health Center.

Data Source and Patient Selection

We retrospectively analyzed data for all types of fusion surgeries of the lumbar and thoracic region between 2010 and 2013 included in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database. This database includes data from over 400 participating hospitals in the United States and Canada. Data acquisition has been validated in the literature, and data is collected in 8-day cycles and monitored weekly to ensure accuracy of data.[9,10] The database captures over 130 variables for each patient. Variables collected include patient demographics, preoperative laboratory results, comorbidities, procedure type, intraoperative variables, postoperative complications, and rates of readmission and reoperation for a period of 30 days.

All patients undergoing thoracic or lumbar spinal fusion surgery between 2010 and 2013 were identified. Patients who had posterior lumbar spine fusion (PLF) were identified using the primary Current Procedural Terminology (CPT) codes 22612, 22630, and 22633. Patients who had anterior lumbar fusion (ALF) were identified using CPT code 22558. Patients who underwent thoracic fusion were identified using CPT codes 22556 and 22610. We used CPT codes 22612, 22634, 22585, 22614, 22632, 22845, and 22842 to identify patients with multilevel spine fusion surgeries. As such, the patient population included those with anterior, posterior, and posterolateral approaches with or without interbody fusion. Patients who received blood transfusions in prior surgery, patients with benign or malignant neoplasms as a principle diagnosis, and patients with American Society of Anesthesiologists (ASA) class 4 were excluded from the analysis. Only patients 18 years or older and with documented variables were included in the study.

Outcomes and Explanatory Variables

The main outcome of this study was intra- or postoperative transfusion. Transfusion was defined as any patient requiring at least 1 U of packaged red blood cells in the operative period. This period was defined by NSQIP as any transfusion received from the time of surgery to 72 hours postoperatively. Patients were grouped into two categories based on region of procedure: thoracic or lumbar fusions.

Demographic characteristics included sex, age, and race. Comorbidities included body mass index (calculated from each patient's height and weight and given in kilograms per square meter), history of diabetes (recorded as history of type 1 or type 2 diabetes), smoking, dyspnea (classified as dyspnea at rest or at moderate excretion), chronic obstructive pulmonary disease, congestive heart failure, dialysis, hypertension, bleeding disorder, steroids intake for chronic diseases, functional health status prior to surgery, and ASA class.

Clinical characteristic variables included operative time for elective surgery, inpatient status, return to the operation room, and preoperative laboratory values (e.g., hematocrit, platelet count, white blood count, serum creatinine, blood urea nitrogen [BUN], and serum sodium). Intraoperative variables of interest included the number of lumbar and thoracic levels operated (single versus multilevel). Postoperative complications of interest included deep surgical site infection, venous thromboembolism (DVT), pulmonary embolism (PE), superficial surgical site infection, myocardial infarction (MI), length of hospital stay, and death.

Statistical Analysis

All statistical analyses were conducted using Stata version 12.0 (StataCorp, LP, College Station, Texas, United States). Pearson chi-square test for categorical variables and Student t test for continuous variable were used to compare patient demographic and preoperative clinical characteristics between patients who received blood transfusion intraoperatively and those who did not. Multivariate logistic regression was conducted to determine independent risk factors for blood transfusion; only preoperative predictor variables with a $p < 0.2$ in univariate analysis were included in the regression model. Multivariate logistic regression was also used to compare the occurrence of complications between patient who received a blood transfusion and those who did not. Extended operative time and hospital length of stay were dichotomized in the multivariable analysis and defined as >75th percentile. Multivariate analysis controlled for demographic and comorbidity variables included in ►Table 1.

Results

Patient Characteristics

A total of 13,695 patients were included in this study: 13,170 had lumbar fusion and 525 had thoracic fusion. ►Table 1 and ►Table 4 summarize the demographic characteristics and clinical and preoperative variables of the patients who underwent lumbar and thoracic fusion. The prevalence of blood transfusion was 31.8% in thoracic spine fusion and was 17.0% in lumbar fusion.

Lumbar Fusion

Significant differences in preoperative characteristics were observed between patients who received transfusions in comparison with patients who did not (►Table 1). Patients who received a blood transfusion were older and more likely to have diabetes, dyspnea, hypertension, bleeding disorders, higher ASA classification, and poorer functional health status prior to surgery but were less likely to be smokers. Patients

Table 1 Demographic and clinical characteristics of patients who underwent lumbar fusion surgery

	Lumbar fusion		
	Not transfused ($n = 10,930$)	Transfused ($n = 2,240$)	p Value
Demographic characteristics			
Age (y)	58.8 ± 13.7	63.7 ± 12.4	<0.001
Sex (%)			<0.001
Female	55.4	61.0	
Male	44.6	39.1	
Race (%)			0.55
White	86.1	86.4	
Black or African American	6.2	6.3	
American Indian or Native	0.4	0.5	
Native Hawaiian or Pacific Islander	0.3	0.1	
Asian	1.5	1.6	
Unknown	5.5	5.1	
Comorbidities			
BMI (kg/m^2)	30.3 ± 6.4	30.5 ± 6.6	0.08
Diabetes (%)			<0.001
Type I	4.6	7.1	
Type II	10.6	13.3	
Smoking (%)	23.3	16.7	<0.001
Dyspnea (%)			<0.001
At rest	0.3	0.3	
Moderate exertion	6.1	9.2	
COPD (%)	4.4	4.9	0.30
CHF (%)	0.2	0.3	0.20
Dialysis (%)	0.1	0.3	0.004
Hypertension (%)	53.9	64.5	<0.001

Table 1 (*Continued*)

	Lumbar fusion		
	Not transfused (*n* = 10,930)	Transfused (*n* = 2,240)	*p* Value
Bleeding disease (%)	1.4	2.6	<0.001
Steroids (%)	3.3	4.5	0.005
ASA class (%)			<0.001
1: no disturbance	3.2	1.5	
2: mild disturbance	53.0	40.2	
3: severe disturbance	43.8	58.4	
Functional health status prior surgery (%)			<0.001
Independent	97.8	96.0	
Partially dependent	2.1	3.7	
Totally dependent	0.1	0.3	
Clinical characteristics			
Multilevel surgery (%)	52.9	75.8	<0.001
Operation time (min)	190.9 ± 92.7	281.0 ± 125.5	<0.001
Elective surgery (%)	95.5	93.2	<0.001
In/outpatient (%)			<0.001
Inpatient	97.7	99.2	
Outpatient	2.3	0.7	
Return to operating room (%)	2.9	5.4	<0.001
Preoperative hematocrit	40.9 ± 4.0	38.8 ± 4.7	<0.001
Preoperative platelet count	248.8 ± 67.5	244.5 ± 74.5	0.007
Preoperative WBC	7.4 ± 2.3	7.2 ± 2.4	0.03
Preoperative serum creatinine	0.90 ± 0.47	0.94 ± 0.51	0.006
Preoperative BUN	16.0 ± 7.1	17.5 ± 7.8	<0.001
Preoperative serum sodium	139.2 ± 2.7	138.9 ± 3.1	<0.001

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; BUN, blood urea nitrogen; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; WBC, white blood count.

who received a blood transfusion were more likely to have had longer operative time, multilevel surgery, inpatient surgery, and higher BUN and creatinine levels preoperatively but were less likely to have had elective surgery and lower preoperative hematocrit and sodium levels.

Significant predictors of blood transfusion as defined by the multivariate analysis (►**Table 2**) included age between 50 and 60 (odds ratio [OR] 1.37, *p* < 0.001) as compared with age < 50, age between 61 and 70 (OR 1.83, *p* < 0.001) as compared with age < 50, age > 70 (OR 2.09, *p* < 0.001) as compared with age < 50, dyspnea (OR 1.14, *p* = 0.005), bleeding disease (OR 1.62, *p* = 0.005), class 3 ASA classification (OR 1.51, *p* = 0.030), multilevel surgery (OR 2.37, *p* < 0.001), extended operative time (>259 minutes; OR 4.03, *p* < 0.001), return to operation room (OR 1.74, *p* < 0.001), and higher preoperative BUN (OR 1.01, *p* = 0.010). Patients who did not require blood transfusion had higher rates of outpatient procedures (OR 0.46, *p* = 0.003) and hematocrit values preoperatively (OR 0.90, *p* < 0.001).

Finally, blood transfusion was associated with the development of deep surgical site infection (OR 2.44, *p* < 0.001) and superficial surgical site infection (OR 1.52, *p* = 0.037). Transfusion was also associated with DVT (OR 2.69, *p* < 0.001), MI (OR 2.85, *p* = 0.004), PE (OR 3.55, *p* < 0.001), and extended length of stay (>5 days; OR 3.06, *p* < 0.001). However, transfusion was not associated with mortality (►**Table 3**).

Thoracic Fusion

Significant differences in preoperative characteristics were observed between patients who underwent thoracic fusion and received a blood transfusion versus the patients who did not (►**Table 4**). Patients who received transfusions were older, were more likely to be female, and had higher ASA classification. However, similar to patients having lumbar surgery, they were less likely to be smokers. Patients who received a blood transfusion were more likely to have had multilevel surgery, longer operative time, higher preoperative BUN levels, and lower preoperative hematocrit levels.

Table 2 Multivariate analysis: significant risk factors for blood transfusion in patients who underwent lumbar fusion surgery

Risk factors	Odds ratio	95% CI	p Value
Age (y)			
50–60	1.37	1.16–1.61	<0.001
61–70	1.83	1.56–2.15	<0.001
> 70	2.09	1.76–2.46	<0.001
Dyspnea	1.14	1.04–1.25	0.005
Bleeding disease	1.62	1.16–2.28	0.005
ASA class 3: severe disturbance	1.51	1.03–2.23	0.030
Multilevel surgery	2.37	2.12–2.64	<0.001
Extended operation time (>259 min)	4.03	3.64–4.46	<0.001
Outpatient	0.46	0.27–0.76	0.003
Return to operating room	1.74	1.38–2.21	<0.001
Preoperative hematocrit	0.90	0.89–0.91	<0.001
Preoperative BUN	1.01	1.00–1.02	0.010

Abbreviations: ASA, American Society of Anesthesiologists; BUN, blood urea nitrogen; CI, confidence interval.

Table 3 Association of blood transfusion with adverse outcomes in patients who underwent lumbar spine fusion surgery

Outcome	Not transfused (%)	Transfused (%)	Multivariate logistic regression[a]		
			Odds ratio	95% CI	p Value
Deep surgical site infection	0.53	1.47	2.44	1.55–3.83	<0.001[b]
Venous thromboembolism	0.55	1.88	2.69	1.77–4.09	<0.001[b]
Superficial surgical site infection	1.00	1.61	1.52	1.03–2.26	0.037[b]
Myocardial infarction	0.20	0.62	2.85	1.41–5.78	0.004[b]
Pulmonary embolism	0.40	1.61	3.55	2.23–5.66	<0.001[b]
Extended length of stay (≥5 d)	21.10	49.46	3.06	2.77–3.27	<0.001[b]
Death	0.14	0.31	1.64	0.64–4.13	0.296

Abbreviation: CI, confidence interval.
[a]Each line represents a separate multivariate logistic regression analysis for each variable and adjusted odds ratio and p value by controlling for multiple-level surgery and all demographics and comorbidities found in ►**Table 2**.
[b]Statistically significant ($p < 0.05$).

Significant predictors of blood transfusion in thoracic fusion as defined by the multivariate analysis (►**Table 5**) included multilevel surgery (OR 3.75, $p < 0.001$), extended operative time (>357 minutes; OR 5.34, $p < 0.001$), and increased preoperative BUN (OR 1.03, $p = 0.028$). However, higher hematocrit level preoperatively (OR 0.91, $p < 0.001$) was noticed in patients who did not receive blood transfusion.

Finally, patients having thoracic fusion who received blood transfusion had longer length of stay (>11 days; OR 1.90, $p = 0.001$) (►**Table 6**). Unlike patients in the lumbar group who received blood transfusion, patients in the thoracic group did not show a significant increase in the rates of DVT and PE (OR 2.85, $p = 0.25$ and OR 5.39, $p = 0.11$, respectively). Because the transfusion protocol was not available in the database, the average hematocrit for those who received transfusion and those who did not is summarized in ►**Table 7** for both lumbar and thoracic fusion groups.

Discussion

In this study, we used a large database to determine predictive factors and investigate complications associated with blood transfusion in patients who underwent spine fusion surgery of the thoracolumbar region. Although it is recognized that spine surgery is associated with hemorrhage and requirements of transfusion,[2,4] the risk factors for transfusion remain unclear. A recent study investigated the preoperative factors associated with blood transfusion in patients who underwent primary posterior lumbar fusion.[8] However, this study was limited to posterior lumbar fusion approaches and did not look at thoracic fusion. In the present study, we investigated preoperative factors associated with blood transfusion in all types of lumbar and thoracic fusion surgeries. Predictive factors and complication rates associated with blood transfusion in thoracolumbar surgery were identified.

Table 4 Demographic and clinical characteristics of patients who underwent thoracic fusion surgery

	Thoracic fusion		
	Not transfused (*n* = 358)	Transfused (*n* = 167)	*p* Value
Demographic characteristics			
Age (y)	59.5 ± 16.0	63.2 ± 12.2	0.006
Sex (%)			0.018
Female	52.5	63.5	
Male	47.5	36.5	
Race (%)			0.918
White	85.8	87.4	
Black or African American	5.0	5.4	
American Indian or Native	0.3	0	
Native Hawaiian or Pacific Islander	0.3	0	
Asian	1.7	1.8	
Unknown	6.9	5.4	
Comorbidities			
BMI (kg/m^2)	30.2 ± 7.7	29.7 ± 6.3	0.561
Diabetes (%)			0.181
Type I	6.7	6.6	
Type II	7.8	10.8	
Smoking (%)	24.6	16.8	0.040
Dyspnea (%)			0.578
At rest	1.7	0.6	
Moderate exertion	7.5	8.4	
COPD (%)	4.2	7.2	0.148
CHF (%)	0.8	0.6	0.769
Dialysis (%)	0	0.6	0.143
Hypertension (%)	56.7	62.9	0.181
Bleeding disease (%)	3.9	3.6	0.859
Steroids (%)	7.0	4.8	0.335
ASA class (%)			0.010
1: no disturbance	3.6	0.6	
2: mild disturbance	32.1	23.4	
3: severe disturbance	64.3	76.1	
Functional health status prior surgery (%)			0.628
Independent	90.0	89.2	
Partially dependent	8.7	10.2	
Totally dependent	1.4	0.6	
Clinical characteristics			
Multiple level surgery (%)	58.4	82.6	<0.001
Operation time (min)	219.0 ± 118.8	335.3 ± 144.2	<0.001
Elective surgery (%)	76.3	76.1	0.966
Inpatient (%)	98.3	100	0.092
Return to operating room (%)	7.3	9.0	0.494
Preoperative hematocrit	39.3 ± 5.3	37.2 ± 4.7	<0.001

(*Continued*)

Table 4 (Continued)

| | Thoracic fusion | | |
	Not transfused (n = 358)	Transfused (n = 167)	p Value
Preoperative platelet count	253.8 ± 95.7	262.1 ± 90.5	0.348
Preoperative WBC	8.2 ± 3.7	7.7 ± 3.1	0.160
Preoperative serum creatinine	0.87 ± 0.54	0.86 ± 0.29	0.898
Preoperative BUN	15.9 ± 7.4	17.4 ± 7.5	0.030
Preoperative serum sodium	138.5 ± 3.0	138.6 ± 3.1	0.83

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; BUN, blood urea nitrogen; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; WBC, white blood count.

Table 5 Multivariate analysis: significant risk factors for blood transfusion in patients who underwent thoracic fusion surgery

Risk factors	Odds ratio	95% CI	p Value
Multiple-level surgery	3.75	2.29–6.15	<0.001
Extended operation time (≥327 min)	5.34	3.40–8.40	<0.001
Preoperative hematocrit	0.91	0.88–0.96	<0.001
Preoperative BUN	1.03	1.01–1.06	0.028

Abbreviations: BUN, blood urea nitrogen; CI, confidence interval.

Table 6 Association of blood transfusion with adverse outcomes in patients who underwent thoracic spine fusion

| Outcome | Not transfused (%) | Transfused (%) | Multivariate logistic regression[a] | | |
			Odds ratio	95% CI	p Value
Deep surgical site infection	2.2	1.2	0.56	0.11–3.01	0.495
Venous thromboembolism	0.8	1.8	2.85	0.46–17.35	0.255
Superficial surgical site infection	3.1	3.6	0.94	0.31–2.81	0.914
Myocardial infarction	0.6	0.6	1.00	0.88–11.44	0.997
Pulmonary embolism	0.6	2.4	5.39	0.67–42.8	0.111
Extended length of stay (≥9 d)	23.2	36.5	1.90	1.22–2.97	0.004[b]
Death	0	1.2	–	–	–

Abbreviation: CI, confidence interval.
[a]Each line represents a separate multivariate logistic regression analysis for each variable and adjusted odds ratio and p value by controlling for multiple-level surgery and all demographics and comorbidities found in ►**Table 4**.
[b]Statistically significant (p < 0.05).

Table 7 Preoperative hematocrit in both lumbar and thoracic groups

	Transfused	Nontransfused	p Value
Lumbar	38.81 ± 4.73	40.91 ± 4.10	<0.001
Thoracic	37.24 ± 4.71	39.33 ± 5.31	<0.001

Our findings showed that the incidence of blood transfusion was higher in patients undergoing thoracic fusion (31.8%) compared with lumbar fusion (17.0%). Our results corroborate a previous study where patients with thoracic arthrodesis had the highest incidence of blood transfusion when compared with all other regions of the spine including cervical, thoracolumbar, and lumbar regions.[11] This result could be partly explained by the fact that thoracic fusion is generally more complex and thus requires longer operative time. Accordingly, the average operative time for the patients undergoing thoracic fusion (transfused: 335.3 minutes versus nontransfused: 219 minutes) was higher than those who underwent lumbar fusion (transfused: 281 minutes versus nontransfused: 190.9 minutes). Basque et al also demonstrated that operative time was associated with

transfusion requirements following primary lumbar fusion.[8] In addition, Zou et al showed that blood loss in lumbar spine surgery was associated with length of surgery.[12] Our results suggests that operative time was associated with transfusion requirements for both thoracic and lumbar fusion surgeries. Furthermore, thoracic fusion tends to involve more fusion segments, which has also been shown to be an independent factor for requiring blood transfusions.[13] The high incidence of transfusion suggests that concern for transfusion should always be present for thoracic and lumbar spine fusion surgeries.

Significant predictors of blood transfusion for patients undergoing lumbar fusion included older age, dyspnea, bleeding disorders, multilevel surgery, ASA class, preoperative high BUN levels, return to the operating room, and extended surgical time. However, multilevel surgery, low preoperative hematocrit, high preoperative BUN, and extended surgical time were predictors of transfusion for thoracic fusion. Our results are in accordance with previous studies.[4,8] Berenholtz et al reported that age, metastatic tumor, diabetes, and female sex were associated with blood transfusion requirements following spine surgery.[4] In addition, Butler et al concluded that patients who were operated for deformity, malignancy, or trauma were at higher risk of requiring transfusions of more than 2 U of packed red blood cells than other surgeries.[14] Furthermore, they identified multilevel surgery (>3 levels) as a significant predictor of requiring transfusion of more than 2 U of packed red blood cells after correcting for other variables. Our results are very similar to those presented by Basques et al,[8] which was expected, as they also used the ACS-NSQIP database. However, we used a larger sample size and included all patients (not limited to primary lumbar fusion) who underwent lumbar or thoracic fusion surgery. Interestingly, higher preoperative hematocrit was associated with lower transfusion for thoracic and lumbar fusion patients. Although the database includes data from many centers, the exact protocol for transfusion is not clear (the threshold for transfusion is not clear). Differences in transfusion protocols can also affect results and decrease or increase the transfusion rates in both groups. Outpatient surgery was associated with a decreased risk of blood transfusion in patients undergoing lumbar fusion. In fact, these patients were less likely to need a transfusion once other factors were controlled for. This result can be explained by less strict hemoglobin monitoring postoperatively in outpatients and a selection bias to send patients home who bleed less intraoperatively.

Patients who received a blood transfusion and underwent thoracic and lumbar fusions had an increased rate of postoperative complications. The authors observed an association between the event of blood transfusion and developing deep and superficial wound infections. Blood transfusion has also been shown to be associated with increased infection rates in other surgical procedures, such as joint replacements in the literature.[6] Furthermore, our results demonstrated an association between the event of blood transfusion and postoperative complications including MI, PE, and DVT for patients having lumbar fusion. However, the strength of the association between transfusion and postoperative complication is biased by lack of standardiza-

tion of transfusion protocols in the database. More studies are required to determine if better cardiac monitoring and anticoagulation protocols may be warranted in patients who receive transfusion following thoracic and lumbar fusion.

Finally, the cost of transfusion on spine procedures is not negligible.[15] Studies have shown that crossmatch-to-transfusion ratios are too high for thoracic and lumbar surgery and play a role in the financial burden of such procedures.[11,16] In addition, the cost of transfusion itself is an important consideration financially. The cost of transfusion in the United States has been estimated to be between $522 and $1,183 (USD) per unit transfused.[17] Thus, clarifying the predictors of transfusion requirements can help reduce cost by identifying the patients who would benefit from preoperative crossmatch and those who will require transfusion. Patients requiring transfusion were also more than threefold likely to stay in the hospital for more than 5 days for lumbar fusion and more than twofold likely to stay more than 9 days for thoracic fusion. Previous studies also showed an association between blood transfusion and extended hospital length of stay.[8] The increase in complication rates and length of stay make the need for transfusion significant from a financial standpoint.

Although data acquisition in the NSQIP database is very well monitored and prospectively collected, certain parameters of interest for this study were missing. These include intraoperative blood loss, adverse reaction to transfusion such as transfusion-related acute lung injury or acute transfusion reactions, and clinical outcomes such as postoperative neurologic status. In addition, the exact transfusion protocol (e.g., hemoglobin, packed cell volume, blood loss rate) used by each institution was not available in the NSQIP database. Therefore, different hospital protocols may have been used but could not be identified. However, the large number of patients included and the high-quality data have advantages that outweigh these limitations.

In conclusion, this large multi-institutional study aimed to identify predictive factors of blood transfusion and examine associated postoperative complications in patients undergoing most common lumbar and thoracic fusion surgeries. Several clinical and operative characteristics were associated with blood transfusion including older age, longer surgery, bleeding disorder, low hematocrit, ASA class of 3, and multilevel surgery in lumbar fusion and increased length of surgery, lower hematocrit, higher preoperative BUN, and multilevel surgery for thoracic fusion. In addition, results of the study demonstrated an association between the event of blood transfusion and development of postoperative complications including MI, DVT, PE, and wound infection. Therefore, pre- and postoperative planning for patients deemed to be at high risk of requiring blood transfusion might reduce postoperative complications in this population.

Peter Jarzem: none
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Michael H. Weber: none

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