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Impact of Cirrhosis on Resource Use and Inpatient Complications in Patients Undergoing Total Knee and Hip Arthroplasty

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Abstract

Background—Cirrhosis is a major cause of morbidity and mortality and is an important risk factor for complications in surgical patients. The purpose of this study was to investigate the association of cirrhosis with postoperative complications, length of stay (LOS), and costs among patients who underwent total knee (TKA) or hip (THA) arthroplasty.

Methods—Using the Nationwide Inpatient Sample between 2000 and 2011, we identified patients who had a primary TKA or primary THA. TKA patients were divided into two groups: 1) cirrhosis (n= 41,464) and 2) no cirrhosis (n= 5,721,297) and THA patients were divided into two groups: 1) cirrhosis (n= 27,401) and 2) no cirrhosis (n= 2,622,539). Patient demographics, comorbidities, perioperative complications, LOS, incremental costs were analyzed. An additional subgroup analysis by cirrhosis etiology was performed.

Results—Multivariable analysis revealed cirrhosis was associated with 1.55 (95%CI: 1.47–1.63) times higher odds of any complication after TKA, and 1.59 (1.50–1.69) higher odds after THA. Adjusted outcomes showed cirrhotic TKA patients had \$1,857 higher costs and 0.30 days longer LOS, and THA cirrhotic patients had \$1,497 higher costs and 0.48 longer LOS. We found similar results for each cirrhosis subtype, but alcohol-related had the highest resource use and complication rate.

Conclusion—Patients with cirrhosis who are undergoing TKA or THA are at a significantly increased risk for perioperative complications, increased LOS and higher costs. The perioperative complications and costs were highest among patients with alcohol-related cirrhosis.

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Keywords

cirrhosis; total knee arthroplasty; total hip arthroplasty; complications; cost; length of stay

INTRODUCTION

Cirrhosis is the irreversible, end-stage of chronic liver disease and is a sequelae of alcoholism, viral hepatitis, and other causes of hepatitis including non-alcoholic fatty liver disease[1,2]. Cirrhosis can lead to complications such as impaired immune function and infection, coagulopathy, renal failure, neurologic dysfunction, and malnutrition[1,3–6]. Ten percent of patients with decompensated cirrhosis require surgical procedures[7] and these patients are at a significantly higher risk for developing surgical complications[8–10]. Yet, patients with cirrhosis who undergo elective surgery have compensated cirrhosis[11]. Over the past decade, as the medical care for cirrhosis has improved and the number of patients living with cirrhosis increases[2], there has been an increase in the number of cirrhotic patients undergoing primary total joint arthroplasty (TJA)[12]. Complications due to cirrhosis following total hip arthroplasty (THA) and total knee arthroplasty (TKA) can lead to an increased risk of perioperative morbidity and mortality[8,13]. Several studies have reported on the outcomes of patients with cirrhosis following TJA[12–16], however, the population-level variation in complications by etiology of cirrhosis is not known.

The objective of this study was to investigate the association of cirrhosis (stratified by subtype) with postoperative outcomes following TKA and THA in a large nationally representative population. Additionally, we evaluated how the risk of complications and economic burden varies across different types of liver cirrhosis.

MATERIALS and METHODS**Study Design and Data Source**

This study was a retrospective analysis using data from the 2000–2011 Nationwide Inpatient Sample (NIS). The NIS is a 20% stratified random sample of hospitalizations in the United States and is part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ)[17]. The NIS is the largest all payer database of inpatient admissions in the United States, comprising about 8 million records, or 20% of all U.S. hospital stays annually.

Study Population

We defined cases of primary TKA and THA using International Classification of Disease, 9th edition, Clinical Modification (ICD-9-CM) procedure codes of 81.51 and 81.54, respectively (Figure 1 and Figure 2, respectively). Patients were excluded if they were less than 18 years of age. Additionally, exclusion criteria were based on the presence of an ICD-9-CM diagnosis codes for the following conditions: acute infection of lower extremity or buttocks, diagnosis suggestive of previous arthroplasty, metastatic cancer, pathological fractures, tibia and fibula fractures, femoral neck fractures, femur fractures, other lower limb fractures[18]. THA patients with dislocation of the hip and pelvic fracture were also

excluded[19]. The final study population was 5,762,761 patients with TKA, of whom 41,464 had cirrhosis, and 2,649,940 patients with THA, of whom 27,401 had cirrhosis.

Outcomes

The primary outcomes of interest were major complications, length of hospital stay (LOS), and total costs. Costs were estimated by multiplying total listed charges by a hospital-specific cost-to-charge ratio provided by HCUP[20]. The HCUP cost-to-charge ratios were derived from hospital accounting reports collected by the Centers for Medicare and Medicaid Services (CMS). Length of stay is the number of inpatient days from admission to discharge. Major complications were identified by ICD-9-CM diagnosis codes and include: postoperative blood transfusion, acute postoperative anemia, thrombocytopenia, acute renal failure, hemorrhage or hematoma/seroma, pneumonia, digestive system complications, deep vein thrombosis, infection, stroke, pulmonary embolism, and disruption of surgical wound (Table 1)[21].

Exposure

The main exposure was cirrhosis defined by ICD-9-CM codes of 571.0–571.5, 070.*, or 996.82. The control group consisted of persons without those codes and also without v18.59 or v12.79. Cirrhosis was categorized into three types for subgroup analysis: alcoholic (571.0–571.3), viral (070.*), and other (571.4, 571.5, 996.82); those with multiple causes of cirrhosis were excluded from the cirrhosis subgroup analyses.

Covariates

We included a number of variables in our study to compare differences in patient populations between cirrhotic and non-cirrhotic groups, and control for these differences in our analysis. These variables include patient age, race, sex, insurance status, and Elixhauser comorbidities[22]. Race was categorized as “White”, “Black”, “Hispanic”, “Other” and “Unknown/Missing”. Insurance status was categorized as Medicare, Medicaid, private insurance, uninsured, and other/unknown. To avoid over parameterization in regression models, we created a composite measure of the Elixhauser comorbidities using a published algorithm[22]. This algorithm was modified slightly to exclude the liver disease comorbidity to avoid collinearity with our main exposure variable, cirrhosis.

Statistical Analysis

We performed a descriptive analysis for all study variables. Comparisons between cirrhotic and non-cirrhotic groups were made using Pearson’s chi-square test for categorical variables and Student’s t-test for continuous variables. We used a p-value threshold of 0.001 to determine a statistically significant difference or effect size. We used SAS software version 9.3 for all analysis. We applied sample weights provided in the NIS to produce national estimates. Survey design procedures accounting for the stratified clustered sampling design of the NIS were used for all descriptive analysis[17]. To estimate the effect of cirrhosis on risk of perioperative and postoperative complications, we used generalized linear regression models with a generalized estimating equations (GEE) approach[23]. The GEE approach is used to account for autocorrelation that occurs due to the clustering of patients by

hospital[24]. All analyses were repeated in subgroups by etiology of cirrhosis– alcoholic, viral, and other.

RESULTS

The demographics of the study population are shown in Table 2. The percentage of TKA and THA patients with cirrhosis was 0.72% and 1.03%, respectively. Patients undergoing TKA with a comorbidity of cirrhosis were younger (mean age: 60.3 vs. 66.7, $p<0.001$) and a higher percentage were males (47.9% vs. 36.3%, $p<0.001$) compared to non-cirrhotic patients. Cirrhotic THA patients were also younger (mean age: 57.1 vs. 65.1, $p<0.001$) and were comprised of more males (57.3% vs. 43.7%, $p<0.001$). Racial and ethnic minorities made up a higher percentage of the cirrhotic group in both TKA (21.2%, $p<0.001$) and THA (20.5%, $p<0.001$). Cirrhotic patients were also more likely to be on Medicaid (11.5% vs. 2.5% in TKA, $p<0.001$; 15.6% vs. 3.0%, $p<0.001$ in THA). Patients with cirrhosis were more likely to have surgery at a teaching hospital in both THA (46% vs. 41%, $p<0.001$) and TKA (55% vs. 47%, $p<0.001$).

A higher percentage of patients with cirrhosis experienced a postoperative complication following both TKA (26.4% vs. 20.2%, $p<0.001$) and THA (31.2% vs. 24.1%, $p<0.001$) procedures, compared to those without cirrhosis (Table 3). Cirrhotic patients in both TJA groups had significant thrombocytopenia, acute renal failure, and hemorrhage or hematoma/seroma compared to controls ($p<0.001$). Cirrhotic patients in the THA group had significantly greater acute postoperative anemia compared to controls ($p=0.002$). There were other significant complications that developed in the cirrhotic groups, however, these occurred in less than 1% of patients (Table 3).

After multivariable adjustment, the odds of any complication after TKA and THA were 1.55 (95% Confidence interval [CI]: 1.47–1.63) and 1.59 (95% CI: 1.50–1.69) times higher among those with cirrhosis compared to those without cirrhosis (Table 4). Based on the multivariate analysis, cirrhosis was associated with a significant increase in the odds of developing acute postoperative anemia, thrombocytopenia, acute renal failure, hemorrhage or hematoma/seroma, device-related complications, infection, and other complications of medical care for both the THA and TKA groups. In the TKA group, cirrhosis was associated with increased odds of disruption of the surgical wound and was associated with decreased odds of pulmonary embolism and digestive system complications. In the THA group, cirrhosis was associated with increased odds of developing pneumonia.

In stratified analysis by cirrhosis etiology, the adjusted odds of complications were higher in all three cirrhosis subgroups (Table 5). The effect size was most pronounced in the alcohol-related cirrhosis group, which had a 2.51 (95% CI: 2.15–2.93) times higher odds of complications compared to non-cirrhotic patients in TKA, and 2.25 (95% CI: 1.93–2.62) times higher odds of complication following THA. The aOR for each statistically significant complication was highest in the alcohol-related cirrhosis group compared to viral hepatitis and other etiology group. In all three groups, the largest effect size was observed for thrombocytopenia.

Cirrhosis was associated with an average of \$1,857 (95% CI: 1704–2010) higher total costs and 0.30 (95% CI: 0.26–0.34) longer average length of stay for a TKA procedure (Table 6). For THA procedures, cirrhosis was associated with \$1,497 (95% CI: 1312–1682) incremental costs and a 0.48 (95% CI: 0.43–0.53) incrementally higher length of stay. Each subgroup of cirrhosis was also associated with statistically significant higher costs and average length of stay for both TKA and THA.

DISCUSSION

The present study looked to identify the association of the various etiologies of cirrhosis on postoperative outcomes, complications and economic burden following THA and TKA. Cirrhosis was associated with higher odds of perioperative complications following both THA and TKA. Furthermore, the odds of perioperative complications varied between the different etiologies of cirrhosis. Patients with alcohol-related cirrhosis were at the highest risk of poor surgical outcomes relative to the other etiologies. To the best of our knowledge, this is the largest study to investigate the impact of various etiologies of cirrhosis on a comprehensive set of postoperative complications.

The available literature on nationally representative data looking at the association of cirrhosis with perioperative complications following TJA is scant. Our study found that patients with cirrhosis in both the THA and TKA groups had increased odds of developing acute postoperative anemia, thrombocytopenia, hematoma/hemorrhage, acute renal failure, device-related complications, infection, and complications of medical care. In a study that utilized a statewide database, Jiang et al[12] studied the periprosthetic joint infection rate in patients with cirrhosis and found that infections were significantly more common in patients with cirrhosis compared to those controls after THA (3.7% vs. 0.7%, $p<0.001$) and TKA (2.7% vs. 0.8%, $p<0.001$). The cirrhosis patients also had significantly increased LOS, readmission, reoperation, mortality and costs. Similarly, Tiberi et al[14] performed a smaller study using data from a single institution and found patients with cirrhosis had significantly more blood transfusions, renal failure, infections, dislocations, revision surgery and mortality. Pneumonia was more common in patients with cirrhosis in the setting of THA. This is similar to the report by Moon et al[16], who also found THA patients with cirrhosis had significantly greater risk of bleeding, coagulopathy, and infection. Surgical wound disruption was significantly more common in cirrhotic patients who underwent TKA, which is similar to the results of Orozco et al[25].

Overall complications in both the THA and TKA groups were significantly higher in those with alcohol-related cirrhosis compared to viral-related and other etiologies of cirrhosis. Alcohol-related cirrhosis causes a stronger inflammatory response resulting in problems controlling the immune system, compared to viral-related cirrhosis[26]. Among patients who were hospitalized due to complications of cirrhosis, alcohol-related cirrhosis was the predominant cause[27]. Alcohol misuse in patients undergoing TJA has been previously reported and was shown to be a significant risk factor for poor outcomes following TJA along with increased LOS[28]. In all three cirrhosis subtypes, the largest effect size was seen for thrombocytopenia. This may be due to the fact that thrombocytopenia is associated with

chronic liver disease[29]; furthermore, thrombocytopenia increases the risk for complications following TJA[13,15,25].

One of the major drivers of medical cost is LOS[30]. Patients undergoing TJA who have more comorbidities are at a significant risk for increased medical costs and LOS[31,32]. It has been estimated that an additional \$12,745 is spent annually on patients with cirrhosis[33]. The results of the present study are in agreement with those of Jiang et al[12] who reported that patients with cirrhosis who underwent THA had an additional cost of \$4,516 and the 2.2 days longer LOS and those who underwent TKA had an additional cost of \$1,532 and 0.6 day longer LOS compared to controls, both of which were statistically significant.

There are several limitations in this study that should be acknowledged. First, the limitations inherent to analysis of data from large administrative databases limit the availability of specific perioperative data. Second, due to the nature of the NIS database, this study only assessed the available inpatient data; as a result, events and outcomes that occurred prior to admission and after discharge were not available. Third, this was a retrospective study that relied on ICD-9 coding, which can lead to errors and/or incomplete coding. Studies have shown that surgical complications tend to be under-reported in administrative data. The actual complication rate is likely to be higher. There is no reason to believe that the reporting of complications would be biased in either direction between cirrhosis and non-cirrhosis groups; therefore the higher odds of complications associated with cirrhosis are likely to be real. A study by Nehra et al[34], demonstrated that most of the ICD-9-CM codes we used to identify cirrhosis have high positive predictive value. Nonetheless, some false positives and false negatives are inevitable.

In conclusion, patients with cirrhosis are at an increased risk for perioperative complications, LOS and higher costs following primary TJA, with alcohol-related cirrhosis having the worse overall outcomes. As the number of TJA performed on patients with cirrhosis increases, patients should receive extensive counseling regarding their risk of adverse outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

HCUP-NIS= Healthcare Cost and Utilization Project- National (Nationwide) Inpatient Sample, PR= Procedure (International Classification of Disease, 9th edition, Clinical Modification (ICD-9-CM) codes, DX= Diagnoses (ICD-9-CM), TKA= Total Knee Arthroplasty

*Some patients met multiple exclusion criteria, so the sum of the individual criteria is higher than the total excluded.

Figure 2.

HCUP-NIS= Healthcare Cost and Utilization Project- National (Nationwide) Inpatient Sample, PR= Procedure codes (International Classification of Disease, 9th edition, Clinical Modification [ICD-9-CM]), DX= Diagnoses codes (ICD-9-CM), TKA= Total Hip Arthroplasty

*Some patients met multiple exclusion criteria, so the sum of the individual criteria is higher than the total excluded.

Table 1

ICD-9-CM Diagnosis Codes for Major Perioperative Complications *

Major Complications	ICD-9-CM codes
Acute postoperative anemia	285.1
Hemorrhage or hematoma/seroma	998.11–998.13, 459.0, 729.92
Infection	998.5
Disruption of surgical wound	998.3x
Thrombocytopenia	287.4, 287.5
Stroke	997.02
Pneumonia	480–486, 997.31, 997.32
Digestive system complications	997.4
Acute renal failure	584.x
Pulmonary embolism	415.11, 415.13, 415.19
Deep vein thrombosis	451.11, 451.19, 451.2, 451.81, 453.40–453.42
Device-related complications	996.4x, 996.66, 996.67, 996.77, 996.78
Complications of medical care, not otherwise specified	999.x

* ICD-9-CM= International Classification of Disease, 9th edition, Clinical Modification

Table 2

Demographics and Hospital Characteristics for Primary Total Knee Arthroplasty and Total Hip Arthroplasty Patients With or Without Cirrhosis, United States 2000–2011 (Weighted).

	Total Knee Arthroplasty			Total Hip Arthroplasty		
	Cirrhosis	No cirrhosis	P-value	Cirrhosis	No cirrhosis	P-value
Number of patients	41,464	5,721,297	<0.001	27,401	2,622,539	<0.001
Age						
Below 40	1.4%	0.6%		4.3%	2.9%	
40–49	12.3%	4.8%		19.4%	8.7%	
50–59	37.9%	19.9%		39.4%	20.4%	
60–69	27.7%	32.9%		22.3%	27.6%	
70–79	16.7%	30.9%		11.6%	27.8%	
80–89	4.0%	10.5%		3.0%	12.0%	
90 and above	0.0%	0.3%		0.0%	0.6%	
Sex			<0.001			<0.001
Female	52.1%	63.7%		42.6%	56.3%	
Male	47.9%	36.3%		57.3%	43.7%	
Race			<0.001			<0.001
Black	11.4%	5.4%		13.4%	5.0%	
Hispanic	6.5%	3.9%		4.1%	2.3%	
White	60.2%	64.7%		60.1%	66.5%	
Other	3.3%	2.7%		3.0%	2.2%	
Insurance			<0.001			<0.001
Medicaid	11.5%	2.5%		15.6%	3.0%	
Medicare	44.4%	57.1%		39.6%	53.3%	
Other	6.4%	3.9%		6.4%	3.3%	
Private	37.8%	36.4%		38.4%	40.5%	
Self-pay / uninsured						
Hospital Location			<0.001			<0.001
Rural	9.7%	13.3%		8.0%	11.1%	
Urban	90.3%	86.7%		92.0%	88.9%	
Hospital Region			<0.001			<0.001

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	Total Knee Arthroplasty		Total Hip Arthroplasty	
	Cirrhosis	No cirrhosis	Cirrhosis	No cirrhosis
Northeast	19.2%	16.8%	20.9%	20.5%
Midwest	20.0%	28.3%	17.8%	27.0%
South	35.9%	36.5%	35.6%	32.0%
West	24.9%	18.4%	25.7%	20.5%
Teaching Hospital	45.9%	40.9%	<0.001	<0.001
Hospital Bed Size			0.045	<0.001
Small	14.3%	15.7%	12.5%	15.3%
Medium	25.5%	24.9%	24.3%	23.9%
Large	60.2%	59.4%	63.2%	60.8%

Table 3

Prevalence of Complications in Patients Who Underwent Total Knee and Total Hip Arthroplasty With a Comparison between Those With and Without a Diagnosis of Cirrhosis

	Total Knee Arthroplasty			Total Hip Arthroplasty		
	Cirrhosis	No cirrhosis	P-value	Cirrhosis	No cirrhosis	P-value
Number of patients	41,464	5,721,297		27,401	2,622,539	
Any complication *	26.39%	20.19%	<0.001	31.24%	24.09%	<0.001
Acute postoperative anemia	17.98%	17.14%	0.06	23.32%	21.39%	0.002
Hemorrhage or hematoma/seroma	1.65%	0.77%	<0.001	2.07%	1.03%	<0.001
Infection	0.14%	0.06%	0.004	0.29%	0.09%	<0.001
Disruption of surgical wound	0.19%	0.07%	<0.001	***	0.01%	***
Thrombocytopenia	7.23%	1.02%	<0.001	7.22%	1.03%	<0.001
Stroke	0.18%	0.15%	0.578	0.19%	0.19%	0.901
Pneumonia	0.82%	0.65%	0.045	0.82%	0.56%	0.009
Digestive System complications	0.35%	0.55%	0.013	0.57%	0.72%	0.178
Acute renal failure	2.51%	1.21%	<0.001	2.99%	1.22%	<0.001
Pulmonary embolism	0.28%	0.44%	0.025	0.11%	0.19%	0.154
Deep vein thrombosis	0.55%	0.58%	0.725	0.32%	0.31%	0.836
Device-related complications	0.19%	0.08%	<0.001	0.40%	0.11%	<0.001
Complications of medical care, not otherwise specified	0.17%	0.10%	0.053	0.25%	0.14%	0.028

The p-values are from a chi-square test comparing surgical complications in cirrhotic vs. non-cirrhotic patients.

* Includes composition of all studied complications

These cells suppressed to comply with HCUP data use agreement prohibiting publication of small cells with less than 11 subjects

Table 4

Multivariable Adjusted Effect of Cirrhosis on Perioperative Complications in Patients Who Underwent Total Knee and Total Hip Arthroplasty*

Outcome	Total Knee Arthroplasty aOR (95% CI)	Total Hip Arthroplasty aOR (95% CI)
Any complication**	1.55 (1.47–1.63)	1.59 (1.50–1.69)
Acute postoperative anemia	1.19 (1.12–1.26)	1.27 (1.19–1.35)
Hemorrhage or hematoma/seroma	2.10 (1.78–2.49)	1.93 (1.59–2.33)
Infection	2.07 (1.17–3.69)	3.07 (1.84–5.11)
Disruption of surgical wound	2.21 (1.34–3.65)	0.97 (0.13–7.12)
Thrombocytopenia	7.91 (7.23–8.67)	7.72 (6.89–8.66)
Stroke	1.22 (0.73–2.04)	0.99 (0.54–1.81)
Pneumonia	1.26 (0.99–1.60)	1.39 (1.03–1.87)
Digestive System complications	0.69 (0.49–0.99)	0.81 (0.57–1.14)
Acute renal failure	1.69 (1.46–1.95)	1.98 (1.67–2.34)
Pulmonary embolism	0.56 (0.37–0.84)	0.53 (0.24–1.19)
Deep vein thrombosis	0.98 (0.73–1.30)	1.12 (0.70–1.79)
Device-related complications	2.25 (1.39–3.66)	2.39 (1.55–3.68)
Complications of medical care, not otherwise specified	1.75 (1.03–2.98)	1.81 (1.06–3.09)

* Table shows the effect of cirrhosis on each surgical complication in both total knee and total hip arthroplasty procedures expressed as the adjusted odds ratio (aOR) and 95% confidence intervals are shown in parentheses. The aOR was calculated using a logistic regression model adjusting for age, race, sex, insurance status, and hospital characteristics.

** Includes composition of all studied complications

Table 5

Adjusted Effect of Cirrhosis Etiology on Perioperative Complications in Total Knee and Total Hip Arthroplasty^{*}

Total Knee Arthroplasty			
Outcome	Alcoholic Cirrhosis	Viral Hepatitis	Other cirrhosis
Any complication ^{**}	2.51 (2.15–2.93)	1.31 (1.24–1.39)	1.92 (1.74–2.13)
Acute postoperative anemia	1.49 (1.25–1.78)	1.14 (1.07–1.22)	1.17 (1.04–1.32)
Hemorrhage or hematoma/seroma	4.64 (3.29–6.67)	1.79 (1.46–2.21)	1.46 (0.97–2.18)
Thrombocytopenia	14.68 (11.91–18.11)	3.23 (2.81–3.70)	12.18 (10.49–14.15)
Pneumonia	1.66 (0.90–3.05)	1.43 (1.08–1.88)	0.67 (0.37–1.23)
Digestive System complications	0.42 (0.11–1.69)	0.82 (0.55–1.22)	0.62 (0.28–1.38)
Acute renal failure	1.37 (0.88–2.15)	1.59 (1.34–1.89)	1.88 (1.42–2.47)
Total Hip Arthroplasty			
Outcome	Alcoholic Cirrhosis	Viral Hepatitis	Other cirrhosis
Any complication ^{**}	2.25 (1.93–2.62)	1.39 (1.29–1.49)	1.98 (1.72–2.27)
Acute postoperative anemia	1.63 (1.39–1.92)	1.19 (1.10–1.28)	1.32 (1.13–1.53)
Hemorrhage or hematoma/seroma	2.08 (1.31–3.29)	1.80 (1.44–2.25)	1.81 (1.18–2.79)
Thrombocytopenia	11.78 (9.41–14.69)	3.71 (3.16–4.36)	10.78 (8.78–13.26)
Pneumonia	1.15 (0.54–2.46)	1.69 (1.21–2.36)	0.85 (0.39–1.83)
Digestive System complications	1.10 (0.52–2.34)	0.86 (0.57–1.29)	0.72 (0.29–1.75)
Acute renal failure	2.04 (1.38–3.00)	1.82 (1.48–2.22)	1.89 (1.31–2.73)

^{*} Table shows the effect of cirrhosis on each perioperative complication in both total knee arthroplasty and total hip arthroplasty procedures and stratified by cirrhosis type expressed as the adjusted odds ratio (aOR) and 95% confidence intervals are shown in parentheses. The aOR was calculated using a logistic regression model adjusting for age, race, sex, insurance status, and hospital characteristics.

^{**} Includes composition of all studied complications

Table 6

Adjusted Incremental Costs and Length of Stay (LOS) of Cirrhotic Patients Compared to Non-Cirrhotic Patients *

Comparison - Total Knee Arthroplasty	Incremental Cost	Incremental LOS
Any Cirrhosis vs. no cirrhosis	\$1,857 (1704–2010)	0.30 (0.26–0.34)
Alcohol-related cirrhosis v. no cirrhosis	\$1,362 (840–1884)	0.65 (0.52–0.78)
Viral cirrhosis vs. no cirrhosis	\$2,175 (1998–2352)	0.24 (0.2–0.28)
Other cirrhosis vs. no cirrhosis	\$481 (147–815)	0.31 (0.23–0.39)
Comparison - Total Hip Arthroplasty	Incremental Cost	Incremental LOS
Any Cirrhosis vs. no cirrhosis	\$1,497 (1312–1682)	0.48 (0.43–0.53)
Alcohol-related cirrhosis v. no cirrhosis	\$1,645 (1136–2154)	0.72 (0.58–0.86)
Viral cirrhosis vs. no cirrhosis	\$1,616 (1404–1828)	0.43 (0.37–0.49)
Other cirrhosis vs. no cirrhosis	\$584 (125–1043)	0.49 (0.36–0.62)

* Values in cells represent the point estimate for the incremental increase in cost or length of stay adjusted for all patient and hospital characteristics, along with the 95% confidence interval shown in parentheses. Incremental length of stay in days