

# World Journal of *Gastroenterology*

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## Retrospective Cohort Study

**Hospital costs, length of stay and prevalence of hip and knee arthroplasty in patients with inflammatory bowel disease**

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**Author contributions:** Ehrenpreis ED was involved in the following portions of the study: Study design, data analysis, manuscript writing, manuscript revisions; Zhou Y was involved in the following portions of the study: Study design, data analysis, manuscript writing, manuscript revisions.

**Institutional review board statement:** The study was reviewed by North Shore University Health System Institutional Review Board and deemed appropriate for exempt status of Institutional Review Board oversight due to the de-identified nature of HCUP-NIS data.

**Informed consent statement:** The clinical data utilized in this study is de-identified and was obtained from a publicly available database. Therefore, informed consent was not required for this study.

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**Abstract****AIM**

To examine the prevalence of hip and knee arthroplasty in patients with inflammatory bowel disease (IBD) by comparing the diagnostic codes for these procedures in patients with IBD and a control group of patients.

**METHODS**

The National Inpatient Sample database (NIS) is part of the Healthcare Cost and Utilization Project (HCUP), the largest publicly available inpatient healthcare database in the United States. The NIS samples about 20% of discharges from all community hospitals participating in HCUP, representative of more than 95% of the United States population, with approximately 7000000 hospitalizations reported annually. NIS contains data on diagnoses, procedures, demographics, length of stay (LOS), co-morbidities and outcomes. ICD-9-CM diagnostic codes for primary hospitalizations for arthroplasty of the hip or knee with a co-diagnosis of IBD [combining both Crohn's disease (CD) and ulcerative colitis (UC)] were used to identify study subjects for cost and LOS analysis for NIS from 1999-2012. Statistical analysis: 1: 2 propensity score matching between IBD vs a control

group based on following factors: Patient age, gender, race, total co-morbidities, # of procedures, admission type, insurance, income quartiles, and hospital bed size, location and hospital teaching status. Categorical variables were reported as frequency and compared by  $\chi^2$  tests or Fisher's exact tests. Individual 1:3 matching was also performed for patients carrying diagnostic codes for CD and for patients with the diagnostic code for UC. After matching, continuous variables were compared with Wilcoxon signed rank or Paired T-tests. Binary outcomes were compared with the McNemar's test. This process was performed for the diagnosis of hip or knee arthroplasty and IBD (CD and UC combined). Prevalence of the primary or secondary diagnostic codes for these procedures in patients with IBD was determined from NIS 2007.

### RESULTS

Costs and mortality were similar for patients with IBD and controls, but LOS was significantly longer for hip arthroplasties patients with IBD, (3.85 +/-2.59 d *vs* 3.68 +/-2.54 d, respectively,  $P = 0.009$ ). Costs, LOS and survival from the procedures was similar in patients with CD and UC compared to matched controls. These results are shown in Tables 1-10. The prevalence of hip arthroplasty in patients with IBD was 0.5% in 2007, (170/33783 total patients with diagnostic codes for IBD) and was 0.66% in matched controls ( $P = 0.0012$ ). The prevalence of knee arthroplasty in patients with IBD was 1.36, (292/21202 IBD patients) and was 2.22% in matched controls ( $P < 0.0001$ ).

### CONCLUSION

Costs and mortality rates for hip and knee arthroplasties are the same in patients with IBD and the general population, while a statistical but non-relevant increase in LOS is seen for hip arthroplasties in patients with IBD. Compared to the general population, arthroplasties of the hip and knee are less prevalent in hospitalized patients with IBD.

**Key words:** Ulcerative colitis; Outcomes; Inflammatory bowel disease; Hip arthroplasty; Knee arthroplasty; Hospital length of stay; Mortality; Crohn's disease

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**Core tip:** Patients with inflammatory bowel disease (IBD) have predisposing risk factors for arthroplasty of the hip and possibly the knee. IBD patients are also at higher risk for thromboembolic events, and longer and more complex hospitalizations for non-intestinal surgeries. Despite these considerations, this study of the National Inpatient Survey, the largest publicly available inpatient healthcare database in the United States, demonstrates the unexpected findings that patients with IBD have similar costs, lengths of stay and mortality when hospitalized for hip and knee arthroplasties. In addition, these surgeries are significantly less prevalent in

patients with IBD than the general population.

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## INTRODUCTION

Rheumatologic complications of inflammatory bowel disease (IBD) are common. Patients with inflammatory bowel disease are at risk for spondyloarthropathies, osteoporosis, bone fractures and avascular necrosis of the hip<sup>[1-8]</sup>. Previous studies have also indicated that patients with inflammatory bowel disease are likely to have longer and more complicated hospitalizations<sup>[9]</sup>, especially when undergoing non-intestinal surgeries. This may be especially true in light of the increased risk of thromboembolic events that occurs in patients with inflammatory bowel disease<sup>[10]</sup>. Despite these considerations, there has been little attention paid to hospital outcomes in patients with IBD that undergo orthopedic procedures. In addition, although it may be assumed that patients with IBD are at higher risk of undergoing arthroplasties of the hip (and possibly the knee), the prevalence of these procedures in the IBD patient population has not been performed. In the current study, we utilized a large national database of hospitalized patients we examined of the effect of a diagnosis of IBD on hospital cost, LOS and survival during primary hospitalizations for hip and knee arthroplasty. We also examined the prevalence of hip and knee arthroplasty in patients with IBD by comparing the diagnostic codes for these procedures in patients with IBD and a control group of patients.

## MATERIALS AND METHODS

### Data source

A review of the 2005-2011 National Inpatient Sample database (NIS) was conducted for this analysis. The NIS is the largest publicly available inpatient healthcare database in the United States. It is part of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality. The NIS contains approximately a 20% sample of discharges from all community hospitals participating in HCUP, representative of more than 95% of the United States population. An estimated seven million hospital admissions per year are reported containing data on primary and secondary diagnoses and procedures, patient demographics, hospital characteristics, length of stay, insurance status, median income by zip code and co-morbidity measures<sup>[11,12]</sup>.

**Table 1 Comparison of length of stay, hospitalization costs, and mortality for hip arthroplasty between patients with inflammatory bowel disease and matched controls**

	IBD (n = 1484)	No IBD (n = 4452)	P value
Mean length of stay (d)	3.85 ± 2.59	3.68 ± 2.54	0.009
Mean cost of hospitalization (\$)	50074.72	33161.78	0.732
Deaths	0	5 (0.11)	0.340

IBD: Inflammatory bowel disease.

**Table 2 Comparison of length of stay, hospitalization costs, and mortality for knee arthroplasty between patients inflammatory bowel disease and matched controls**

	IBD (n = 1484)	No IBD (n = 7560)	P value
Mean length of stay (d)	3.53 ± 1.96	3.54 ± 1.76	0.864
Mean cost of hospitalization (\$)	45319.13	25714.03	0.441
Deaths	4 (0.16)	16 (0.21)	0.605

IBD: Inflammatory bowel disease.

### Sample selection

The International Classification of Diseases, 9<sup>th</sup> Revision Clinical Modification (ICD-9-CM) diagnostic codes was used to identify the study population of interest. The ICD-9-CM is used to code and classify morbidity data from hospitals, physicians' offices and National Center for Health Statistics surveys<sup>[13]</sup>. The dataset was created by searching NIS for all patients presenting with ICD-9-CM codes for a primary diagnosis of arthroplasty of the hip or knee with a co-diagnosis of IBD [combining both Crohn's disease (CD) and ulcerative colitis (UC)] and individually for patients with a diagnosis of CD or UC.

### Statistical analysis

Continuous variables were reported as mean ± standard deviation and median (range). The normality assumption for continuous variables was assessed using the Shapiro-Wilk test. Continuous variables were compared between IBD and controls by two-sample T-test or Wilcoxon rank-sum test as appropriate. Categorical variables were reported as frequency (percentage) and were analyzed by  $\chi^2$  tests or Fisher's exact test for co-diagnosed disease vs control comparisons. Propensity score matching method is widely used in observational studies to reduce selection bias. To fairly compare the outcomes of interests between for co-diagnosed disease group and controls, we conducted the 1:2 for IBD vs controls or 1:3 for UC and CD vs controls propensity score matching between patients with co-diagnosed disease vs controls using greedy 8-to-1 match algorithm<sup>[14]</sup>. Propensity scores were computed by modeling the

probability of having the co-diagnosed disease through multivariable logistic regression with following factors: age, gender, race, total numbers of co-morbidities in records, total numbers of procedures in records, admission type, insurance, income quartiles, hospital beds, hospital control, hospital location, hospital region and hospital teaching status. Prevalence of hip and knee arthroplasty were determined by selecting the group of patients from the 2007 HCUP database with of diagnostic codes for Crohn's disease or ulcerative colitis and also having either primary or secondary diagnostic codes for either hip or knee arthroplasty. A control group for each IBD group having hip or knee arthroplasty was then created from the 2007 database by 3:1 matching using the categorical variables mentioned above. Statistical analyses were performed on SAS 9.3 (Cary, NC) Windows platform. A  $P < 0.05$  was considered as statistically significant.

The study was reviewed by NorthShore University HealthSystem Institutional Review Board (IRB) and deemed appropriate for exempt status of IRB oversight due to the de-identified nature of HCUP-NIS data.

## RESULTS

Procedure costs for hip and knee arthroplasties were similar for patients with IBD and for controls. However, LOS was statistically but not clinically longer for hip arthroplasties patients with IBD compared to controls, (3.85 +/-2.59 d vs 3.68 +/-2.54 d, respectively,  $P = 0.009$ ). Survival from the procedures was similar in both groups. These results are shown in Tables 1 and 2. Procedure costs, LOS and survival for hip and knee arthroplasties were also similar for patients with CD and UC when compared to controls. Results for patients with CD and UC undergoing hip arthroplasties are seen in Tables 3, 4, 5 and 6. Results for patients with CD and UC undergoing knee arthroplasties are seen in Tables 7, 8, 9 and 10.

The prevalence of hip arthroplasty in patients with IBD was 0.5% in 2007, (170/33783 total patients with diagnostic codes for IBD) and was 0.66% in matched controls ( $P = 0.0012$ ). The prevalence of knee arthroplasty in patients with IBD was 1.36% in 2007, (292/21202 IBD patients) and was 2.22% in matched controls ( $P < 0.0001$ ).

## DISCUSSION

Spondyloarthropathies are the most common extra-intestinal manifestations of IBD. IBD-associated spondyloarthropathies have a variety of forms including pauciarticular peripheral arthritis, polyarticular peripheral arthritis, sacroiliitis and spondylitis<sup>[1]</sup>. These and other musculoskeletal abnormalities may occur in up to 50% of patients with IBD<sup>[2-8,15-17]</sup>. Although generally treated with medical therapy, the occasional requirement for surgery as a specific treatment of

**Table 3 Comparison of length of stay, hospitalization costs hip arthroplasty between patients with Crohn's disease and matched controls**

		<i>n</i>	mean ± SD	Median	Min	Max	<i>P</i> value
Length of stay (d)	Controls	2601	3.70 ± 2.95	3	0	101	0.082
	CD	867	3.84 ± 2.25	3	1	25	
Total charges (\$)	Controls	2539	48596 ± 27763.6	41393	7428	342434	0.630
	CD	847	48941.9 ± 28236.1	41187	2025	372931	

CD: Crohn's disease.

**Table 4 Comparison of Mortality for Hip Arthroplasty between Patients with Crohn's disease and Matched Controls *n* (%)**

	Controls	CD	<i>P</i> value
Alive	2598 (99.96)	867 (100)	1.00
Dead	1 (0.04)	0 (0)	

CD: Crohn's disease.

**Table 5 Comparison of length of stay, hospitalization costs for hip arthroplasty between patients ulcerative colitis and matched controls**

		<i>n</i>	mean ± SD	Median	Min	Max	<i>P</i> value
Length of stay (d)	Controls	1863	3.72 ± 2.27	3	0	34	0.5157
	UC	621	3.87 ± 3.01	3	1	49	
Total charges (\$)	Controls	1799	50966.2 ± 29412.4	43153	2703	291387	0.7605
	UC	596	52620.7 ± 34203.1	43704.5	145	307530	

UC: Ulcerative colitis.

**Table 6 Comparison of mortality for hip arthroplasty between patients ulcerative colitis and matched controls *n* (%)**

		UC	<i>P</i> value
Alive	1859 (99.89)	620 (100)	<i>P</i> = 1.00
Dead	2 (0.11)	0 (0)	

UC: Ulcerative colitis.

IBD-related spondyloarthropathies could increase the likelihood that patients with IBD will undergo orthopedic surgery. Patients with IBD also have up to a 40% greater risk of bone fractures and a higher prevalence of osteoporosis compared to the general population<sup>[1,4-6,8]</sup>. Avascular necrosis of the hip may also occur in patients with IBD receiving corticosteroid treatment<sup>[2,7,8]</sup>.

Hospital LOS, complications, costs, in-hospital adverse events, mortality and readmission rates

**Table 7 Comparison of Length of stay, hospitalization costs for knee arthroplasty between patients with crohn's disease and matched controls<sup>1</sup>**

		<i>n</i>	mean ± SD	Median	Min	Max	<i>P</i> value
Length of stay (d)	Controls	4032	3.59 ± 2.22	3	0	82	0.5894
	CD	1344	3.57 ± 2.19	3	0	55	
Total charges (\$)	Controls	3965	45161 ± 27971.7	38408	1002	552569	0.5738
	CD	1317	44975.6 ± 26145.8	38353	8598	234950	

<sup>1</sup>Cleaned data. CD: Crohn's disease.

**Table 8 Comparison of mortality for knee arthroplasty between patients with Crohn's Disease and matched controls<sup>1</sup> *n* (%)**

	Controls	CD	<i>P</i> value
Alive	4022 (99.83)	1341 (99.78)	0.7183
Dead	7 (0.17)	3 (0.22)	

<sup>1</sup>Cleaned data. CD: Crohn's disease.

associated with a variety of conditions, including hip and knee replacements are subject to public reporting<sup>[18-22]</sup>. These data are a useful means to ensure accountability for individual hospitals and to determine areas of discrepancy in the medical system. However, the impact of a pre-existing IBD on patient outcomes for medical and surgical hospitalizations has received little attention. Our group has recently published an analysis of the NIS database that demonstrated the surprising finding that patients with IBD have improved survival when hospitalized for acute myocardial infarction. We hypothesized that this might reflect an unexpected effect of anti-inflammatory agents, particularly TNF-alpha inhibitors<sup>[23]</sup>.

Intestinal and non-intestinal surgery in patients with IBD has been associated with a higher risk of thromboembolic events, post-operative complications and prolonged hospital LOS<sup>[9,10,24-26]</sup>. It would therefore be anticipated that patients with IBD undergoing hip or knee arthroplasties are likely to have more complications, with higher costs, LOS and mortality with these procedures. Because of these considerations, patients with IBD and their healthcare providers should benefit from a better understanding of the risks and costs associated with undergoing these procedures.

We chose the NIS database from HCUP as it has been previously used to investigate the epidemiology and cost factors occurring during hospitalizations for a variety of diseases<sup>[27-32]</sup>. Our study demonstrates that the economics of hip and knee arthroscopies, including costs, LOS and mortality, were similar for patients with IBD and controls. The only statistical (but not clinical) difference found was that the LOS was significantly

**Table 9** Comparison of length of stay, hospitalization costs for knee arthroplasty between patients with ulcerative colitis and matched controls

		<i>n</i>	mean ± SD	Median	Min	Max	<i>P</i> value
Length of stay (d)	Controls	3546	3.59 ± 2.24	3	1	74	0.364
	UC	1182	3.50 ± 1.67	3	1	30	
Total charges (\$)	Controls	3465	46545.8 ± 28108	39769	2025	502498	0.727
	UC	1145	46681.3 ± 27892.7	39813	4550	428244	

**Table 10** Comparison of mortality for knee arthroplasty between patients with ulcerative colitis and matched controls<sup>1</sup> *n* (%)

	Controls	UC	<i>P</i> value
Alive	3535 (99.77)	1180 (99.92)	0.336
Dead	8 (0.23)	1 (0.08)	

<sup>1</sup>Cleaned data.

longer for hip arthroplasties patients with IBD, (3.85 +/-2.59 d vs 3.68 +/-2.54 d, respectively,  $P = 0.009$ ). This finding is not likely to be clinically relevant. There were also no differences in costs, LOS and mortality between patients carrying the specific diagnostic codes for CD or UC and matched controls. Our study also demonstrates the unexpected finding that in the group of patients undergoing hospitalization, having a diagnosis of IBD is associated with a lower prevalence of hip and knee arthroplasties. The prevalence of hip arthroplasty in patients with IBD was 0.5% in 2007 compared to 0.66% in 3:1 matched controls ( $P = 0.0012$ ). The prevalence of knee arthroplasty in patients with IBD in 2007 was 1.36% compared to 2.22% in matched controls ( $< 0.0001$ ).

Similarities in the costs and mortality associated with hip and knee arthroplasties in patients with IBD, along with relatively comparable LOS as determined in this analysis should be reassuring to patients and their practitioners with IBD. These findings suggest that the immediate occurrence of complications in the IBD patient group undergoing hip and knee arthroplasties is probably not higher than patients in the general public. However, this methodology and data analysis does not determine whether late thromboembolic events are more likely to occur in patients with IBD. Patients with IBD are in general at higher risk for thromboembolic events and following these procedures, may have prolonged immobilization and casting. For these reasons, appropriate use of antithrombotic therapy and careful monitoring for thromboembolic events is required in patients with IBD subsequent to their hospitalizations for hip and knee arthroplasty. In addition, one study showed a higher rate of reoperation for hip arthroplasty ion patients with IBD<sup>[33]</sup>.

The paradox of lower prevalence of these surgeries in hospitalized patients with IBD compared to the general population may be explained in several ways.

It is possible that because of known risk, IBD patients may be undergoing more intensive screening and treatment for osteoporosis compared to the general population. As a consequence, precautionary measures to prevent hip fractures and other orthopedic injuries may occur more frequently. It is also possible that there is more hesitancy in performing these surgeries on an elective basis in patients with IBD. Because the NIS database reviews hospitalized patients only, patients having the diagnostic codes for CD or UC that are hospitalized could also represent a sicker group of patients in whom elective procedures are more limited. Nonetheless, the possibility that hip and knee arthroscopies are less commonly performed in patients with IBD should be encouraging to patients and their healthcare providers. Evaluation of outpatient databases and further analyses of large and patient databases such as NIS will be required in the future to fully understand the mechanisms associated with this finding.

Similar to other retrospective studies that utilize data derived from large databases, analysis of the NIS is subject to various limitations. These include the potential of inaccuracy of ICD-9-CM diagnostic coding in the database and that inpatient discharge data is only representative of hospitals participating in HCUP<sup>[10,11]</sup>. When a group of patients is studied using NIS, there is always a possibility that diagnostic codes for chronic illnesses such as IBD may not be included when patients are admitted to the hospital, particularly if suffering from life-threatening conditions<sup>[34]</sup>. Missing data is common in large databases such as NIS and is accounted for by statistical analysis.

In summary, this investigation of a large inpatient database shows that the costs, LOS and mortalities in patients undergoing arthroscopy of the hip or knee are essentially similar in patients with IBD compared to the general population. The study also revealed the unexpected finding that patients with IBD have a lower the prevalence of these procedures, possibly because of better screening for osteoporosis improved fracture prevention.

## COMMENTS

### Background

Comorbidity is defined as the existence of pre-existing conditions that enhance the likelihood of adverse outcomes. By definition, the presence of preexisting co-morbidities are expected to have a negative impact on outcomes in patients that are hospitalized for medical conditions, including surgeries. Some studies

have shown that patients with inflammatory bowel disease (IBD) have longer, more complex hospitalizations, especially for non-intestinal surgeries. Because IBD patients often develop spondyloarthropathies, osteoporosis and avascular necrosis of the hip, the economics of orthopedic surgeries in patients with IBD is a highly relevant topic. However, the prevalence, costs, hospital length of stays and mortality for hip and knee arthroplasties have not been investigated in the IBD population.

### Research frontiers

The following are important areas of clinical research that are related to the information provided in this study; (1) screening and treatment for osteoporosis in patients with IBD; and (2) economics of medical care in patients with IBD.

### Innovations and breakthroughs

The economics of hip and knee arthroplasty in patients with IBD have not been previously investigated in the medical literature. The authors' group has recently demonstrated that patients with IBD have improved survival when hospitalized for acute myocardial infarction, possibly because of effects of immunosuppressant medications<sup>[13]</sup>. In the current study, they found that patients with IBD have similar hospital length of stays, costs and in-hospital mortality when undergoing hip and knee arthroplasty. Compared to the general population, these surgeries are less common in patients with IBD.

### Applications

The information obtained in this study will help clinicians understand the economics of hip and knee arthroplasty patients with IBD. Future studies may focus on determining the effect of screening for osteoporosis and other methods that may lower the likelihood that patients with IBD will require these surgeries.

### Peer-review

The study is well written and welcome. With practical importance, it shows no difference between the IBD patients and general population for hip and knee arthroplasty in a large cohort of patients.

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