

# Validity of Same-Side Reoperation After Total Hip and Knee Arthroplasty Using Administrative Databases

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**ABSTRACT:** Many arthroplasty outcome studies use administrative data to evaluate complications and mortality. Most databases use *International Classification of Diseases, Ninth Revision* or *Current Procedural Terminology* codes, which lack laterality information. This study determined the frequency with which a second operation occurs on the same side after total hip replacement (THR) and total knee replacement (TKR) and identified variables associated with ipsilateral reoperation. In a hospital-based sample of patients undergoing multiple THR or TKR, the side of the index operation was compared with the side of the

subsequent operation. Concordance was defined as the percentage of same-side reoperations. Overall concordance was 23% for THR and 22% for TKR, suggesting most reoperations were on the contralateral hip or knee. This study provides estimates of misclassification of reoperation after lower extremity arthroplasty when conducting orthopedic research with administrative data. Studies using these data should be aware of this limitation, and efforts should be made to limit reoperation to revision THR and TKR.

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## INTRODUCTION

Administrative databases can be powerful tools for health services research as an alternative to expensive and lengthy prospective studies.<sup>4,6</sup> These datasets typically use the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes<sup>3</sup> or *Current Procedural Terminology, Fourth Edition (CPT-4)* codes,<sup>2</sup> neither of which include information on laterality (ie, surgical side). The lack of laterality indicators in these coding schemes limits the use of administrative data for research involving the appendicular skeleton. For extremity surgery, one must be able to identify the side operated on to accurately identify revision procedures. Inferences

about treatment effectiveness can be severely limited because when relying on administrative database codes, researchers cannot differentiate between revision surgeries and new primary procedures on the contralateral side.

The frequency of total joint replacement (hip, knee, shoulder) is expected to increase from the current estimates of approximately 500,000 replacements per year to more than 800,000 by the year 2030, as baby boomers reach retirement age.<sup>1</sup> Research using administrative data can be challenging due to the lack of laterality indicators. Thus, the purpose of this study was to determine the proportion of second operations that occur on the ipsilateral joint and whether patient factors that can be identified using administrative datasets (eg, gender, age) were predictive of ipsilateral total joint revision.

## MATERIALS AND METHODS

Two hospital databases at one hospital were linked to obtain laterality information for the procedures of interest: the hospital billing system and the operating room

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**TABLE 1**

TYPES AND FREQUENCY OF INDEX SURGICAL PROCEDURES

ICD-9 Procedure Description	Index ICD-9 Procedure Code	Frequency of Index Procedure
Knee arthroplasty		
Total knee replacement	81.54	784
Revision of knee replacement	81.55	99
Hip arthroplasty		
Total hip replacement	81.51	795
Partial hip replacement	81.52	5
Revision of hip replacement	81.53	203

Abbreviation: ICD-9, International Classification of Diseases, Ninth Revision.

scheduling system. Using the hospital's billing system, patients who had  $\geq 2$  total knee replacement (TKR) or total hip replacement (THR) surgeries between January 1, 1998, and October 31, 2003, were identified by ICD-9 codes (Table 1). Primary and revision TKR and THR were identified through the use of the standard ICD-9 codes for those procedures. Bilateral procedures were excluded from the analysis. The billing system also provided the age and gender of patients. This file was linked with the operating room scheduling system, which provided clinical information on the side of surgery. Concordance was defined as a second procedure that occurred on the same side as the index procedure. Age-specific and gender-specific concordance was calculated, as was concordance by time between index surgery and second surgery. Predictability of laterality using this concordance measure was defined as agreement  $>80\%$  (ipsilaterality, or localization to the same side of the body). Conversely, an inverse concordance of  $<20\%$  was considered substantial discordance (contralaterality, or localization to the opposite side of the body). Approximate 95% confidence intervals were calculated for all concordance values. All analyses were performed using SAS for Windows version 9.0 software (SAS Institute, Cary, NC).

**RESULTS**

Patients undergoing THR and TKR were most often women, with a median age of 67 years (Table 2). Index surgeries of patients undergoing THR were more likely to occur on the right side, whereas index surgeries of those undergoing TKR were evenly distributed between the left and right sides. Overall, discordance was observed for both THR and TKR for any second procedure (23%

**TABLE 2**

PATIENT CHARACTERISTICS AT INDEX OPERATION

	Knee Arthroplasty (n = 881)	Hip Arthroplasty (n = 1002)
Gender		
Male	301 (34.2%)	414 (41.3%)
Female	580 (65.8%)	588 (58.7%)
Age, y		
Mean	66.6	63.4
Median	68	66
Range	23-93	18-93
Side		
Right	416 (47.2%)	554 (55.3%)
Left	410 (46.5%)	442 (44.1%)
Bilateral	55 (6.2%)	6 (0.6%)
Concordance, % (95% CI)		
All second procedures	22 (19, 25)	23 (20, 26)
Second procedure, revision arthroplasty	62 (53, 70)	69 (64, 74)
Second procedure, primary arthroplasty	0.6 (0.2, 1.9)	0.7 (0.3, 1.8)

Abbreviation: CI, confidence interval.

and 22%, respectively). When the second procedure was coded as primary arthroplasty, discordance was extremely high ( $<1\%$ ); when it was coded as revision arthroplasty, concordance was relatively poor (69% for THR; 62% for TKR).

For primary TKR (Table 3), predictable discordance ( $<20\%$ ) was demonstrated for women, patients  $\geq 65$  years, and time since index surgery  $>3$  months. For revision TKR, predictable concordance ( $>80\%$ ) was demonstrated only for patients  $<40$  years.

For primary THR, predictable discordance was demonstrated for both men and women, for patients  $>40$  years, and for all surgery  $>3$  months. For revision THR, time since index surgery  $<3$  months was related to predictable concordance.

**DISCUSSION**

A primary limitation of using administrative data for orthopedic health services research is the lack of information on the side of surgery, which is particularly important in the study of revision surgery or reoperation. This analysis quantified the frequency of contralateral versus ipsilateral surgery for a second lower extremity arthroplasty procedure. These concordance values may be used

**TABLE 3**

CONCORDANCE BY INDEX PROCEDURE AND DEMOGRAPHIC INFORMATION INDEPENDENT OF TYPE OF SECOND PROCEDURE

	Index Knee Arthroplasty		Index Hip Arthroplasty	
	Primary	Revision	Primary	Revision
Gender (95% CI)				
Male	30 (25, 36)	67 (50, 80)	15 (11, 19) <sup>a</sup>	55 (45, 66)
Female	18 (15, 22) <sup>a</sup>	43 (31, 57)	13 (10, 16) <sup>a</sup>	59 (49, 68)
Age, y (95% CI)				
<40	60 (27, 86) <sup>b</sup>	100 (40, 100) <sup>a,b</sup>	15 (7, 28) <sup>a</sup>	56 (23, 85) <sup>b</sup>
40-49	53 (26, 68)	75 (36, 96) <sup>b</sup>	17 (10, 28) <sup>a</sup>	62 (41, 79)
50-64	23 (18, 29)	62 (44, 77)	14 (10, 19) <sup>a</sup>	48 (36, 61)
≥65	19 (15, 22) <sup>a</sup>	40 (27, 54)	13 (10, 16) <sup>a</sup>	61 (51, 71)
Time since surgery, mo (95% CI)				
<3	37 (24, 51)	67 (36, 89) <sup>b</sup>	34 (24, 44)	85 (69, 94) <sup>a</sup>
3-6	18 (12, 26) <sup>a</sup>	50 (27, 73) <sup>b</sup>	9 (5, 15) <sup>a</sup>	64 (44, 81)
6-12	25 (20, 32)	50 (30, 70)	14 (9, 20) <sup>a</sup>	50 (35, 65)
12-23	19 (14, 25) <sup>a</sup>	47 (25, 71) <sup>b</sup>	13 (8, 18) <sup>a</sup>	35 (23, 50)
≥24	21 (15, 28)	54 (33, 74)	10 (6, 17) <sup>a</sup>	61 (45, 75)

Abbreviation: CI, confidence interval.

<sup>a</sup> Concordance <20% or >80%.

<sup>b</sup> Low sample size (<20 cases).

by future health services researchers to conduct sensitivity analyses using their own databases.

Concordance can range from 0% (all contralateral) to 100% (all ipsilateral). Therefore, a concordance value of 50% represents a “coin flip” as to whether a subsequent operation is contralateral or ipsilateral. The further from 50% agreement lies, the more likely the researcher can predict the true side of the subsequent surgery in an administrative database. A concordance of 20% (discordance) would be biased toward the contralateral side (80% of all reoperations would be to the opposite side), and a concordance of 80% would be biased toward the ipsilateral side (80% of all reoperations would be to the same side). Eighty percent concordance would provide a predictable and reasonable chance that the procedure is a revision if the study is adequately powered to account for this level of uncertainty. Given that administrative databases often include hundreds of thousands of surgical cases, it would be feasible to account for this level of uncertainty using sensitivity analysis.

If the 20% and 80% figures are used to determine predictable discordance and concordance, respectively, the results of this study suggest that administrative database analysis of second procedures after primary THR and TKR can be performed with relative confidence except

when the second procedure is coded as a revision arthroplasty. It should be understood that most second procedures will be to the contralateral joint unless the second procedures are coded as revisions, because most second procedures after a primary TKR and THR are contralateral primary TKR and THR. This makes studies of revision surgery after total joint replacement using administrative databases problematic unless revision surgery is restricted to revision codes and even then, concordance is <70% for both TKR and THR.

Further research should explore the laterality for other common orthopedic procedures or potentially “sided” conditions or procedures in other medical disciplines. Regarding the current use of administrative data for orthopedic research, these findings provide guidance by which orthopedic researchers may adequately power their studies for sensitivity analyses corresponding to the inverse of the concordance values of those procedures with high concordance (>80%) or discordance (<20%). Studies of reoperation in mid-range concordance (20%-80%) should be conducted with caution, particularly as the concordance values get closer to 50%. Although administrative databases provide a rich resource due to large sample sizes and the inclusion of all procedures in a geographic area, the limitations of unknown laterality should not be underestimated.

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