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Effect of provider volume on resource utilization for surgical procedures of the knee

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Abstract Operating-room time and patient disposition on discharge are important determinants of healthcare resource utilization and cost. We examined the relation between these determinants and hospital/surgeon volume for anterior cruciate ligament (ACL) reconstruction and meniscectomy procedures. Patients undergoing ACL reconstruction (18,390 cases) and meniscectomy (123,012 cases) were extracted from the State Ambulatory Surgery Databases for the years 1997–2000. Surgeon and hospital volume were divided into low-, intermediate-, and high-volume categories. Multivariate logistic regression models were used to estimate the adjusted association between surgeon and hospital volume and patient discharge status and operating-room time. Patients undergoing ACL reconstruction or meniscectomy performed by low-volume surgeons were significantly more likely to be non-routinely discharged as compared to high-volume surgeons (adjusted odds ratio 3.5, 95% confidence interval 1.7–7.2 for ACL reconstruction; adjusted odds ratio 2.0, 95% confidence interval 1.6–2.3 for meniscectomy). The mean operating-room time for performing ACL reconstruction or meniscectomy was significantly higher in low- and intermediate-volume surgeons and hospitals as compared to high-volume surgeons and hospitals ($p \leq 0.001$). High-volume providers utilize healthcare resources more efficiently. Our findings may help surgeons and hospitals in optimizing resource utilization and cost for routinely-performed ambulatory surgery procedures.

Keywords Anterior cruciate ligament reconstruction · Meniscectomy · Resource utilization · Operating-room time · Healthcare utilization project

Introduction

Routinely performed surgical procedures like anterior cruciate ligament (ACL) reconstruction [2, 8, 18, 19, 33] and meniscectomy [5, 15, 35] have been shown to have a high rate of success in improving knee function. These procedures are increasingly performed in outpatient settings, using arthroscopic techniques, with the intention to reduce healthcare resource consumption and cost [9, 30, 37]. Efficient resource utilization has been increasingly stressed since the capitation system based on diagnostic related groups and managed care system came into effect [29]. Outcome measures like operating-room time and patient discharge status are important determinants of healthcare resource utilization. It is thus a priority to study factors that affect these measures of efficiency and resource utilization for routinely-performed high-volume procedures like ACL reconstruction and meniscectomy.

It has also been previously shown that operating-room time is a major cost component for surgical procedures [20, 22, 25, 39]. Similarly, non-routine patient discharge has been associated with higher total hospital charges [42].

Many previous studies have attempted to define the relationship between provider volume and outcomes or measures of resource utilization for musculoskeletal surgeries, primarily hip and knee replacement [11, 13, 16, 21, 23, 24, 26, 31, 38, 41]. However, to our knowledge, there are no previous studies evaluating the relationship between provider volume and measures of resource utilization for ambulatory surgery procedures like ACL reconstructionand meniscectomy.

The objective of our study was to evaluate the relation between provider volume and patient discharge status and operating-room time for ACL reconstruction and meniscectomy. We hypothesized that surgeons and hospitals with higher caseloads have higher rate of routine patient discharge and shorter operating-room time.

Materials and methods

Database description

The State Ambulatory Surgery Databases (SASD) for the years 1997–2000 were used for this study [40]. The analysis was conducted using data for the states of Colorado (CO), Maryland (MD), New York (NY), and Utah (UT). The SASD is a part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ). The SASD contain information on all ambulatory surgery procedures performed in the state for a given year.

The datasets provide the following information: Hospital identifiers [AHRQ sponsored and American Hospital Association (AHA) identifiers], synthetic surgeon identifiers, unique patient visit identifier, and procedure and diagnosis codes classified according to the International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) [1]. There is one primary diagnosis/procedure code and up to 14 secondary diagnosis/procedure codes in the datasets. The databases also contain information on patient demographics and discharge status.

The HCUP has assigned validation and quality assessment of these datasets to an independent contractor [34]. The validation was performed by reviewing the univariate statistics for all numeric data elements, frequency distributions for all categorical and some continuous data elements, checking range against standard norms, and performing edit checks that identify inconsistencies between related data elements. The SASD have also been compared to the AHA annual survey databases and the Freestanding Outpatient Surgery Center (FOSC) database, maintained by the SMG marketing group [14]. The data for most facilities in the SASD appeared to be complete and consistent with other data sources.

The combined four-year datasets for the five states contained information on 32,440 patients who underwent ACL reconstruction and 195,597 patients who had a meniscectomy.

Sample selection

Data were extracted separately for ACL reconstruction and meniscectomy. All records with ICD-9-CM primary procedure code for ACL reconstruction (81.45) and for meniscectomy (80.6) were initially included in the analysis (Figs. 1 and 2). From these records, only patients with ICD-9-CM diagnostic codes specific to old disruption of anterior cruciate ligament (717.83) and sprain of anterior cruciate ligament (844.2) were selected for ACL reconstruction analysis. Patients with ICD-9-CM codes representing a diagnosis of derangement, bucket handle tear or a simple tear of the meniscus or cartilage were retained for meniscectomy (Appendix). These diagnoses represent most of the patients undergoing ACL reconstruction or meniscectomy, and homogeneity in the type of cases included for the analysis was also achieved.

Patients with a primary or secondary diagnosis of bone infection in the leg, malignancy, pathological fracture or fracture due to injury in the leg bones were excluded from the analysis for both procedures. These criteria are justified, since outcomes for these patients can be expected to be very different from other patients. A complete description of inclusion/exclusion criteria used for our study can be found in the Appendix. In addition, 738 (2.3%) ACL reconstruction cases with <45 min of operating-room time, and 5,400 (2.8%) meniscectomy cases with <20 min of operating-room time, were considered implausible and therefore excluded.

ACL reconstruction and meniscectomy are often performed with other simultaneous procedures. In such cases, the operating-room time and discharge status would not be solely attributable to our procedures of interest. Hence, we only included patients who had a primary procedure code for either ACL reconstruction or meniscectomy and a secondary diagnosis code for procedures like excision of bone or tendon for graft, excision of local lesion, arthroscopy, or synovectomy (which are a part of ACL reconstruction or meniscectomy surgeries), or none (Appendix). Patients having a secondary procedure code for any other procedures were excluded from the analysis. Moreover, synovectomy performed for patients with a diagnosis of rheumatoid arthritis is a complex procedure. Hence, records with a diagnosis of rheumatoid arthritis (0.027% for ACL reconstruction, and 0.175% for meniscectomy) were also excluded.

There were 18,390 records for ACL reconstruction and 123,012 records for meniscectomy included in the final analysis. A flow chart of the procedure inclusion/exclusion is presented in Figs. 1 and 2.

Outcome measures

The outcome variables of interest included patient discharge status and operating-room time. Patient discharge status was coded into routine and non-routine discharge. Non-routine discharge included transfer to another hospital, skilled nursing facility, intermediate-care facility, or home health care. Routine discharge reflects patients who were discharged home.

Operating-room time was calculated in minutes for every procedure. It was defined as the total time actually in the operating room, exclusive of pre-operative (preparation) and post-operative (recovery) time. Operating-room time was only available in the New York State datasets, and therefore the analysis of this outcome was restricted to this sub-population.

Main effects

The primary predictor variables included surgeon and hospital volume. The databases contain a unique synthetic primary-surgeon identifier for each surgeon, which is consistent over all 4 years in the databases. This is a fixed-key (one-to-one) encryption of the supplied primary-surgeon number. The surgeon volume was derived by counting the number of ACL reconstruction or meniscectomy procedures for the study period using this unique identifier. Surgeon volume was then divided into three categories (for ACL reconstruction, low volume represents <25 procedures, intermediate volume represents ≥25–<75 procedures, and high volume rep-

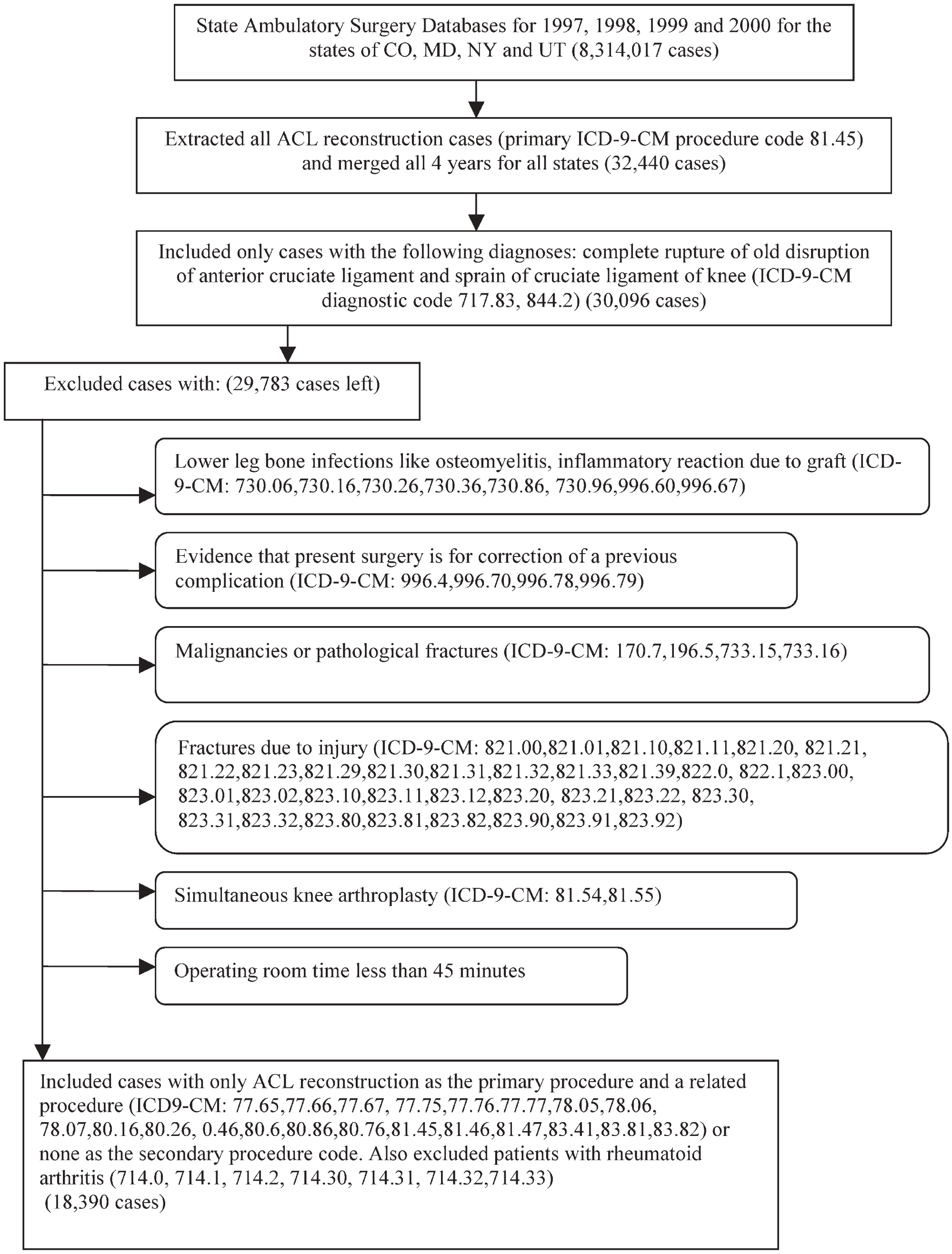

Fig. 1 Algorithm of case inclusion/exclusion for ACL reconstruction

resents ≥75 procedures; and for meniscectomy low volume represents <75 procedures, intermediate volume represents ≥75–<175 procedures, and high volume represents ≥175 procedures).

Similarly, each hospital had a unique hospital identifier which was used to determine the three categories of hospital volume for the study period (for ACL reconstruction, low volume represents <125 procedures, intermediate volume represents ≥125–300 procedures, and high volume represents ≥300 procedures; and for meniscectomy low volume represents <600 procedures, intermediate volume represents ≥600–1,200 procedures, and high volume represents ≥1,200 procedures).

The cut-offs for surgeon and hospital volume were chosen to have approximately similar percentages of procedures in each category and also to have clinically meaningful cut-offs. This approach has been well-described and previously used in the literature [4, 17, 21, 23, 36]. Missing surgeon volume was encountered in 2,442 (13.3%) and 8,328 (6.8%) of ACL and meniscectomy cases, respectively. None of the hospital identifiers were missing. In order to test the impact of missing surgeon identifiers on our results, a sensitivity analysis was performed. Records with missing surgeon volume were first assumed to belong to the lowest surgeon-volume category, and the analyses were re-run. Similarly, this procedure was carried out after substituting missing surgeon volume as the middle and highest surgeon-volume categories.

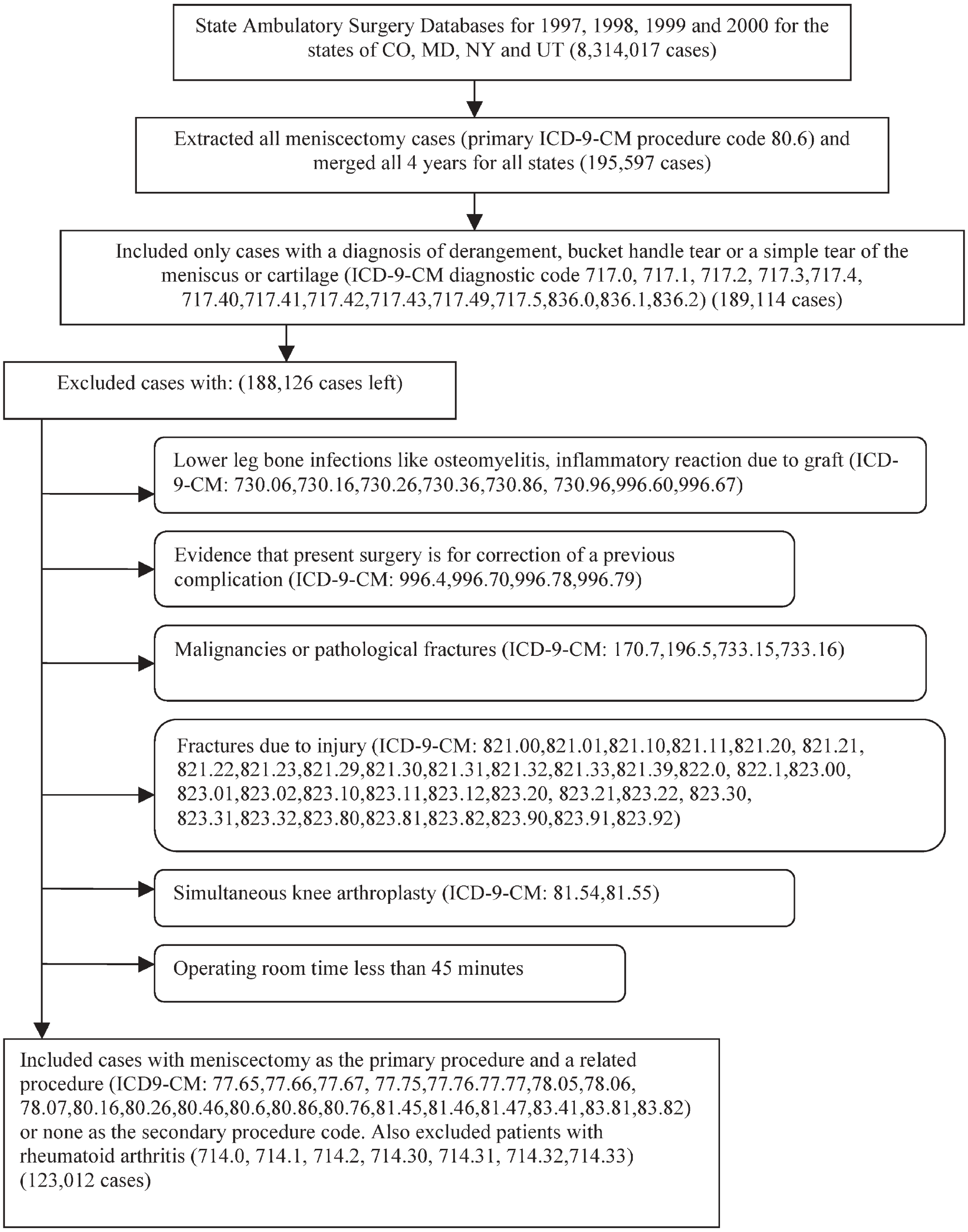

Fig. 2 Algorithm of case inclusion/exclusion for meniscectomy

Covariates

Covariates available from SASD include age, sex, and comorbidity (Charlson index modified by Deyo) [6, 10] of the patient. The Charlson index modified by Deyo measures comorbidity by assigning scores 1, 2, 3, or 6 to each of the comorbid conditions present in a patient. These scores are then added to provide a single index score, which measures the overall comorbidity of the patient. Charlson's index was dichotomized depending on whether the case had a comorbid condition or not, since patients undergoing ACL reconstruction or meniscectomy were healthy, on average.

Statistical analysis

Each of the analyses mentioned below were performed for both ACL reconstruction and meniscectomy procedures. Univariate and bivariate analyses were performed using means, medians, and proportions in percentage.

Multivariate logistic and linear regression models were used to examine the risk-adjusted association between outcomes and surgeon/hospital volume. The surgeon-volume models were controlled for hospital volume (as a continuous variable), and similarly the hospital-volume models were adjusted for surgeon volume (as a continuous variable). Operating-room time, which was used as a continuous variable, had a skewed distribution and therefore was modeled using a logarithmic transformation.

Adjusted odds ratios with 95% confidence intervals were used to express the strength of association between the outcome and

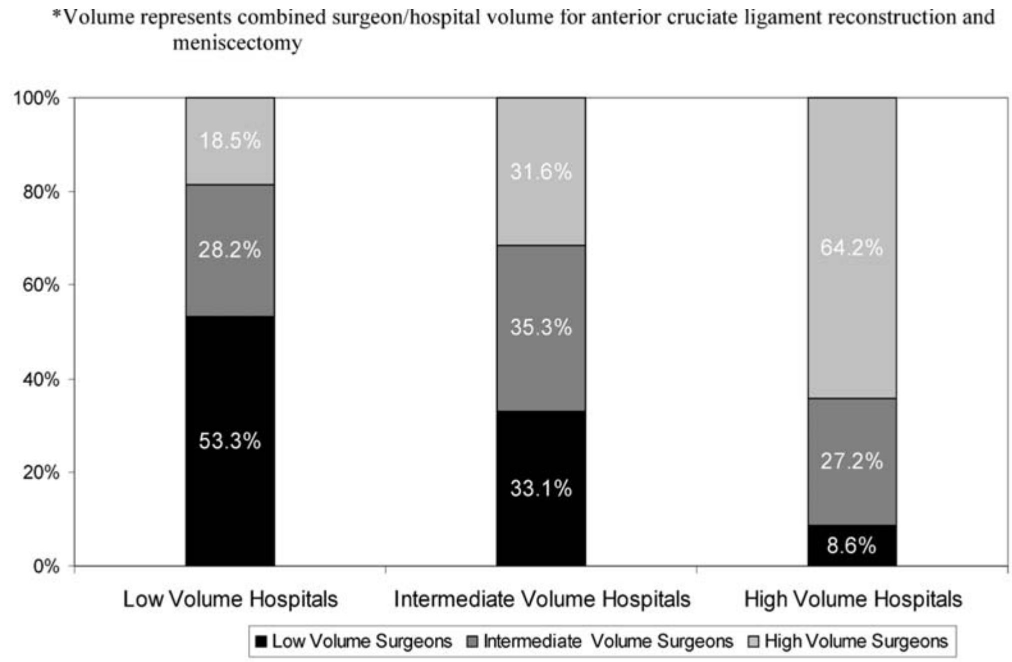

Fig. 3 Distribution of surgeon volume* as a proportion of hospital volume* categories for ACL reconstruction and meniscectomy for the years 1997 through 2000 for the states of CO, MD, NY and UT, USA

surgeon or hospital volume. For operating-room time, the White test [43] was performed to determine heteroscedasticity. The estimated parameters were also corrected by using a smearing factor to adjust for heteroscedasticity and logarithmic transformation [3, 28].

Incremental odds ratios were used to determine whether every increase in hospital/surgeon volume (categories) was associated with an increased risk of the outcome. This is a more stringent and accurate approach than the Mantel extension-trend statistic [27], and requires that all of the incremental odds ratio estimates be greater than (less than) 1 in order to confirm a dose–response relationship.

The statistical analysis was conducted using Intercooled STATA for Windows (version 7.0) (Stata Corporation, College Station, TX, USA).

Results

A majority of patients included in our analysis were male (59.3%), with a mean age of 29 years for ACL reconstruction and 47 years for meniscectomy (Table 1). Patients were mostly healthy, with a mean Charlson's index of 0.1.

Most patients had a routine disposition on discharge (99%). The median operating-room time was 125 min for ACL reconstruction and 55 min for meniscectomy (Table 2).

Approximately 34% of ACL reconstruction and 32% of meniscectomy procedures were performed by low-volume surgeons (Table 3). It can be observed from a combined distribution of ACL reconstruction and meniscectomy in Fig. 3 that low-volume surgeons operate mostly in low-volume hospitals (53.3% procedures) whereas high-volume surgeons perform most procedures in high-volume hospitals (64.2% procedures).

The multivariate logistic regression modeling showed that patients operated for ACL reconstruction by low and intermediate volume surgeons were 3.5 (95% confidence interval 1.7–7.2) and 1.6 (95% confidence interval 0.7–3.4) times more likely to be non-routinely discharged as compared with patients operated by high-volume surgeons (Table 4). Incremental odds ratios were above one for low- and intermediate-volume surgeons, indicating a dose–response relationship (Table 5). For meniscectomy the risk-adjusted odds ratios of non-routine discharge for patients operated by low-volume surgeons was 2.0 (95% confidence interval (CI) 1.6–2.3), and that for intermediate-volume surgeons was 1.02 (95% CI 0.8–1.2) when compared with high-volume surgeons. These results were confirmed with a positive trend analysis.

The mean operating-room time for low-volume (149±9 min) or intermediate-volume (137±9 min) ACL reconstruction surgeons was significantly higher than high volume surgeons [122±9 min; p<0.001 (Table 6)]. Similarly, for meniscectomy the mean operating-room time was 72±6 min for low-volume surgeons, and 64±6 min for intermediate-volume surgeons. These values were significantly higher than those for high-volume surgeons (53±6 min; p<0.001 [Table 6]).

The mean operating-room times for low-volume hospitals (150±9 min for ACL reconstruction and 71±5 min for meniscectomy) or intermediate-volume hospitals (132±9 min for ACL reconstruction and 66±6 min for meniscectomy) were significantly higher

Table 1 Selected characteristics of patients undergoing ACL reconstruction or meniscectomy. *ACL* anterior cruciate ligament, *N* total number of patients

Baseline characteristics	ACL reconstruction (*N*=18,390)	Meniscectomy (*N*=123,012)
Age (years)		
Mean [standard deviation]	29.4 [10.5]	47.3 [15.4]
Missing	0	2
Sex		
Male	10,908 (59.3%)	72,889 (59.3%)
Female	7,481 (40.7%)	50,108 (40.7%)
Missing	1 (0%)	15 (0%)
Mean Charlson's index [standard deviation][a]	0.06 [0.5]	0.1 [0.8]
Mean number of diagnosis on this discharge [standard deviation][a]	2.3 [1.3]	2.4 [1.4]

[a]There were no missing values

Table 2 Selected outcomes of patients undergoing ACL reconstruction or meniscectomy. *ACL* anterior cruciate ligament, *N* total number of patients

Outcome	ACL reconstruction (*N*=18,390)	Meniscectomy (*N*=123,012)
Patient disposition on discharge		
Routine	18,232 (99.1%)	121,924 (99.1%)
Non-routine	87 (0.5%)	992 (0.8%)
Missing	71 (0.4%)	96 (0.1%)
Median operating-room time (min)	125	55
25th percentile of operating-room time (min)	96	40
75th percentile of operating-room time (min)	165	75
Missing[a]	10,951 (59.6%)	43,459 (35.3%)

[a]High number of missing values due to the availability of operating-room time only in NY state databases

Table 3 Distribution of ACL reconstruction and meniscectomy by hospital- and surgeon-procedure volumes

Hospital volume For ACL reconstruction[a]	Surgeon volume			
	<25 (in %)	≥25–<75 (in %)	≥75 (in %)	Total (in %)
<125	19.8	10.0	1.5	31.3
≥125–<300	9.0	12.6	5.6	27.2
≥300	5.4	12.4	23.9	41.7
Total	34.2	35.0	31.0	100.2
For meniscectomy[b]				
	<75 (in %)	≥75–<175 (in %)	≥175 (in %)	Total (in %)
<600	15.3	13.3	4.0	32.6
≥600–<1,200	9.6	12.2	11.8	33.6
≥1,200	6.8	9.8	17.1	33.7
Total	31.7	35.3	32.9	99.9

[a] *N*=15,948. Sample size differs from Tables 1 and 2 due to missing primary surgeon identifiers in 13.3% of ACL reconstruction cases. The total is not 100% due to rounding error

[b] *N*=114,684. Sample size differs from Tables 1 and 2 due to missing primary surgeon identifiers in 6.8% of meniscectomy cases. The total is not 100% due to rounding error

than for high-volume hospitals [129±14 min for ACL reconstruction and 52±6 for meniscectomy; $p<0.001$ (Table 6)].

The results from sensitivity analysis performed by imputing values for missing surgeon volume were similar to the original analysis.

Discussion

To our knowledge, this is the first attempt to investigate whether provider volume impacts resource utilization for ambulatory surgery procedures like ACL reconstruction and meniscectomy. We used combined four-year data

Table 4 Association between surgeon and hospital volume, and non-routine patient discharge for ACL reconstruction and meniscectomy

	Volume	Outcome rate (in%)	Adjusted[a] odds ratio (95% CI)
Surgeon			
ACL reconstruction	<25	0.9	3.5 (1.7–7.2)
	≥25–<75	0.4	1.6 (0.7–3.4)
	≥75	0.2	1.0
Meniscectomy	<75	1.4	2.0 (1.6–2.3)
	≥75–<175	0.7	1.02 (0.8–1.2)
	≥175	0.5	1.0
Hospital			
ACL reconstruction	<125	1.0	2.3 (1.2–4.3)
	≥125–<300	0.2	0.4 (0.1–0.9)
	≥300	0.3	1.0
Meniscectomy	<600	1.6	3.2 (2.6–4.1)
	≥600–<1,200	1.2	4.6 (3.7–5.8)
	≥1,200	0.2	1.0

[a]Adjusted for age, Charlson's index, sex, and either surgeon volume or hospital volume

Table 5 Trends analysis by surgeon and hospital volume for non-routine patient discharge

	Volume	Incremental odds ratio
Surgeon		
ACL reconstruction	≥75	1.0
	≥25–<75	2.2
	<25	2.9
Meniscectomy	≥175	1.0
	≥75–<175	1.5
	<75	4.6
Hospital		
ACL reconstruction	≥300	1.0
	≥125–<300	0.4
	<125	6.6
Meniscectomy	≥1,200	1.0
	≥600–<1,200	4.6
	<600	0.7

Table 6 Adjusted (adjusted for age, Charlson's index, sex, and either surgeon volume or hospital volume) estimates (all estimates are adjusted for smearing and are statistically significant at the 0.001 level) of operating-room time by surgeon and hospital volume for ACL reconstruction and meniscectomy

	Volume	Operating-room time (minutes)	Standard deviation (minutes)
Surgeon			
ACL reconstruction	<25	149	9
	≥25–<75	137	9
	≥75	122	9
Meniscectomy	<75	72	6
	≥75–<175	64	6
	≥175	53	6
Hospital			
ACL reconstruction	<125	150	9
	≥125–<300	132	9
	≥300	129	14
Meniscectomy	<600	71	5
	≥600–<1,200	66	6
	≥1,200	52	6

from ambulatory surgeries performed in the states of Colorado, Maryland, New York and Utah to examine whether surgeon and hospital volume were related to patient discharge status and operating-room time. We found a clear and consistent trend towards better resource utilization with high provider volume. The likelihood of non-routine patient discharge increased with decreasing surgeon volume for ACL reconstruction and meniscectomy. Similarly, the operating-room times were significantly higher for low- and intermediate-volume surgeons and hospitals than for high-volume surgeons and hospitals.

Non-routine discharge of patient has been shown to be associated with higher hospital charges in patients undergoing total knee arthroplasty [42]. It has also been described to be predictive of decline in independent living after surgery [7]. In our analysis, the likelihood of non-routine discharge increased with lower surgeon volume for ACL reconstruction and meniscectomy. These results suggest that high-volume surgeons discharge their patients' home without transferring them to another facility for further care after surgery. Transfer to another facility implies that the patient loses additional work days, is subject to additional suffering from prolonged hospital or nursing-home stay, and uses more healthcare resources.

Few studies on musculoskeletal diseases have looked at operating-room time as an outcome. The mean ACL reconstruction or meniscectomy operating-room times were significantly lower ($p \leq 0.001$) for high-volume surgeons and hospitals as compared to intermediate- and low-volume surgeons and hospitals in the present investigation. Farnworth et al. [12] studied the difference in operating-room time for ACL reconstruction with/without partial meniscectomy between attending orthopaedic surgeons and senior orthopaedic residents. They found that the operating-room and anesthesia time were significantly lower for attending surgeons as compared to residents. Also, due to increased operating-room time, the average operating-room cost increased by $661.85 per patient if the procedure was performed by residents [12]. Several other studies have also attributed operating-room time as one of the important cost components [20, 22, 25, 32, 39]. In a study on carotid endarterectomy, the authors concluded that although lower resource utilization such as reduced length of stay has been achieved, operating-room costs still remain a limiting factor in control of healthcare costs [32]. Further decreases in hospital costs therefore have to stem from operating-room cost and time in the operating room [32]. Even small variations in operating-room time between surgeons and hospitals could make a difference when savings for the overall patient population are considered.

We would like to acknowledge the limitations of our study. Firstly, there was no information on severity of cases in the datasets. Availability of severity grading would have allowed additional risk-adjusting of outcomes. Secondly, no information was available on postoperative clinical indicators of improvement such as laxity of the knee, pain amelioration, muscle strength, and functional status of the knee. Thirdly, there is no evidence that coding in SASD has been validated against clinical data. However, it is unlikely that miscoding would occur systematically in a certain group of hospitals or surgeons and thus bias can be assumed to be minimal. Lastly, in spite of our ability to track surgeons longitudinally, a few surgeons may have moved to a particular state towards the end of the observational period, and they would be incorrectly classified as low-volume providers.

In summary, we found a clear and consistent trend towards better resource utilization for patients undergoing ACL reconstruction and meniscectomy with increasing provider volume. This represents additional evidence to studies encouraging policies aimed at more efficient healthcare resource utilization. It is essential to study these relationships in today's healthcare environment due to limited healthcare resources in every country and rising costs. Valuable healthcare resources could be used more efficiently if the volume–resource utilization relationship is determined in other unexplored areas of surgery. However, it is also important to recognize that policy makers and regulatory bodies need to look at a wide spectrum of factors before making changes to the existing pattern of surgical workload distribution among providers.

Appendix

Inclusion criteria

For anterior cruciate ligament (ACL) reconstruction

– All ambulatory surgery procedures with the following primary procedure code:
  81.45 – Other repairs of cruciate ligaments

– The ACL reconstruction surgery should have one of the following diagnostic code (any diagnosis):
  717.83 – Old disruption of anterior cruciate ligament
  844.2 – Sprain of cruciate ligament of knee

For meniscectomy

– All ambulatory surgery procedures with the following primary procedure code:
  80.6 – Excision of meniscus of knee

– The meniscectomy surgery should have one of the following diagnostic code (any diagnosis):
  717.0 – Old bucket–handle tear of medial meniscus
  717.1 – Derangement of anterior horn of medial meniscus

717.2 – Derangement of posterior horn of medial meniscus
717.3 – Other and unspecified derangement of medial meniscus
717.4 – Derangement of lateral meniscus
717.40 – Derangement of lateral meniscus, unspecified
717.41 – Bucket-handle tear of lateral meniscus
717.42 – Derangement of anterior horn of lateral meniscus
717.43 – Derangement of posterior horn of lateral meniscus
717.49 – Other derangement of lateral meniscus
717.5 – Derangement of meniscus, not elsewhere classified
836.0 – Tear of medial cartilage or meniscus of knee, current
836.1 – Tear of lateral cartilage or meniscus of knee, current
836.2 – Other tear of cartilage or meniscus of knee, current

Exclusion criteria

For ACL reconstruction and meniscectomy

– Patients with diagnosis of lower-leg bone infection:
730.06 – Acute osteomyelitis of lower leg
730.16 – Chronic osteomyelitis of lower leg
730.26 – Unspecified osteomyelitis
730.36 – Periostitis without mention of osteomyelitis
730.86 – Other infections involving bone in diseases classified elsewhere
730.96 – Unspecified infection of bone
996.60 – Infection of inflammatory reaction due to unspecified internal prosthetic device, implant, and graft
996.67 – Infection or inflammation due to presence of unspecified orthopedic device, implant and graft

– Patients with a diagnostic code that indicates that present surgery is for correction of a previous complication of ACL reconstruction or meniscectomy:
996.4 – Mechanical complication of internal orthopedic device, implant, and graft
996.70 – Other complications of unspecified internal (biological) (synthetic) prosthetic device, implant, and graft
996.78 – Other complications of internal orthopedic (biological) (synthetic) prosthetic device, implant, and graft
996.79 – Other complications of internal (biological) (synthetic) prosthetic device, implant, and graft

– Patients with malignancies or pathological fractures of tibia, fibula or femur:
170.7 – Malignant neoplasms of long bones of lower limb
196.5 – Secondary and unspecified malignant neoplasm of lymph nodes in inguinal region and lower limb
733.15 – Pathological fracture of other specified part of femur (other than neck)
733.16 – Pathologic fracture of tibia or fibula

– Patients with fracture of tibia, fibula, patella or femur due to injury:
821.00, 821.01, 821.10, 821.11, 821.20, 821.21, 821.22, 821.23, 821.29, 821.30, 821.31, 821.32, 821.33, 821.39 – Fracture of other and unspecified parts of femur (other than neck)
822.0, 822.1 – Fracture of patella
823.00, 823.01, 823.02, 823.10, 823.11, 823.12, 823.20, 823.21, 823.22, 823.30, 823.31, 823.32, 823.80, 823.81, 823.82, 823.90, 823.91, 823.92 – Fracture of tibia and fibula

– Patients undergoing knee arthroplasty along with a ACL reconstruction or meniscectomy:
81.54 – Total knee replacement
81.55 – Revision of knee replacement

– Patients with a diagnosis of rheumatoid arthritis:
714.0 – Rheumatoid arthritis
714.1 – Felty's syndrome
714.2 – Other rheumatoid arthritis with visceral or systemic involvement
714.30 – Polyarticular juvenile rheumatoid arthritis, chronic or unspecified
714.31 – Polyarticular juvenile rheumatoid arthritis, acute
714.32 – Pauciarticular juvenile rheumatoid arthritis
714.33 – Monoarticular juvenile rheumatoid arthritis

– Patients with less than 45 minutes of operating room time for ACL reconstruction and less than 20 minutes of operating room time for meniscectomy

Procedures included as a part of ACL reconstruction or meniscectomy

For ACL reconstruction

77.65 – Local excision of lesion or tissue of bone from femur
77.66 – Local excision of lesion or tissue of bone from patella
77.67 – Local excision of lesion or tissue of bone from tibia and fibula
77.75 – Excision of bone for graft from femur
77.76 – Excision of bone for graft from patella
77.77 – Excision of bone for graft from tibia and fibula
78.05 – Bone graft from femur

78.06 – Bone graft from patella
78.07 – Bone graft from tibia and fibula
80.16 – Other arthrotomy of knee
80.26 – Arthroscopy of knee
80.46 – Division of knee joint capsule, ligament, or cartilage
80.6 – Excision of semilunar cartilage of knee
80.76 – Synovectomy of knee joint
80.86 – Other local excision or destruction of lesion of knee joint
81.46 – Other repairs of collateral ligaments
81.47 – Other repair of knee
83.41 – Excision of tendon for graft
83.81 – Tendon graft
83.82 – Graft of muscle or fascia

For meniscectomy

77.65 – Local excision of lesion or tissue of bone from femur
77.66 – Local excision of lesion or tissue of bone from patella
77.67 – Local excision of lesion or tissue of bone from tibia and fibula
77.75 – Excision of bone for graft from femur
77.76 – Excision of bone for graft from patella
77.77 – Excision of bone for graft from tibia and fibula
77.79 – Excision of bone for graft from other bones
78.05 – Bone graft from femur
78.06 – Bone graft from patella
78.07 – Bone graft from tibia and fibula
80.16 – Other arthrotomy of knee
80.26 – Arthroscopy of knee
80.46 – Division of knee joint capsule, ligament, or cartilage
80.76 – Synovectomy of knee joint
80.86 – Other local excision or destruction of lesion of knee joint
81.45 – Other repairs of cruciate ligaments
81.46 – Other repairs of collateral ligaments
81.47 – Other repair of knee
83.41 – Excision of tendon for graft
83.81 – Tendon graft
83.82 – Graft of muscle or fascia

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