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Characterizing efficiency in the ambulatory surgery setting: An analysis of operating room time and cost savings in orthopaedic surgery

Uchechi Iweala[a,**], Danny Lee[b,*], Ryan Lee[b], Jeffrey H. Weinreb[b], Joseph R. O'Brien[c], Warren Yu[b]

[a] George Washington University in Washington, DC, New York University's Hospital for Joint Diseases, USA
[b] George Washington University in Washington, DC, USA
[c] Washington Spine and Scoliosis Institute at OrthoBethesda in Bethesda, MD, USA

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ABSTRACT

Changing surgical settings for orthopaedic procedures could drive reductions in operative time and reduce healthcare costs. Time-cost differences were calculated using estimated operating room costs by utilizing the ACS-NSQIP database. Multivariate analyses were generated from propensity-matched cohorts to assess differences between inpatient/outpatient outcomes, and whether surgical length increased risk for complications. Outpatient procedures demonstrated time-cost savings of $1716.06. Generally, inpatient procedures demonstrated increased rates of major/minor complications, reoperation, extended LOS, and unplanned readmission ($p < 0.001$). Overall, longer operative times increased the risk for postoperative complications ($p \leq 0.001$). More elective orthopaedic procedures done on an outpatient basis may result in substantial time-cost savings.

1. Introduction

1.1. Background

Rising healthcare costs continue to be a significant challenge in the United States (US). Today, per capita healthcare spending is $10,739, accounting for 18% of GDP.[1] Given the current spending trajectory, the Medicare Hospital Insurance trust fund is projected to be unable to fully cover costs as early as 2026.[2] In light of this financial picture, it is increasingly important for all healthcare stakeholders to understand whether there are potential opportunities to reduce costs while maintaining or improving quality of care. One potential opportunity is to reduce the cost of surgery. A significant component of surgical cost is time. The cost of time in the operating room is estimated to be $37 per minute.[3]

This study explores the possibility that changing surgical settings for orthopaedic procedures could drive reductions in operative time and therefore reduce costs to the system. Our approach consists of three distinct parts:

1) **Time difference and cost savings:** We examine whether there are differences in operative times for common orthopaedic procedures done in an inpatient versus outpatient setting. We hypothesize that outpatient procedures have shorter operative times than the same procedures done in inpatient settings. In instances where operative time differences exist, we calculate the cost difference of the procedure as a whole, using the $37/minute benchmark.
2) **Risk assessment**: We examine whether operative setting is an independent risk factor for complications. We hypothesize that there are no differences in complication rates or severity of complications across inpatient and outpatient settings.
3) **Complications:** We examine whether shorter operative times result in fewer patient complications. We hypothesize that shorter operative times lead to fewer complications.

2. Methods

The ACS-NSQIP database was queried for patients who had undergone any of the following procedures – total hip arthroplasty (THA), total knee arthroplasty (TKA), anterior cruciate ligament (ACL) repair/reconstruction, microdiscectomy, anterior cervical discectomy and fusions (ACDF), one-level lumbar fusion, distal radius fracture fixation, or olecranon fracture fixation – from 2005 to 2016.[4,5] These patients were isolated based on their primary Current Procedure Terminology (CPT) codes, outlined in Appendix A. Non-elective surgeries, emergent surgeries, those with invalid operative times, and those with known resident-physician involvement were excluded. 536,274 patients were ultimately included for analysis.

* Corresponding author.
** Corresponding author.
E-mail addresses: uaiweala@gmail.com (U. Iweala), dannylee@gwu.edu (D. Lee).

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In order to calculate the time-cost difference, as defined by, "Time-Cost Difference = [(Average time it takes to complete procedure as an inpatient) – (Average time it takes to complete procedure as an outpatient)] x $37/minute," patients within each procedural group were stratified based on whether they had undergone inpatient or outpatient surgeries.[3] The sample of 536,274 patients was analyzed as a whole, as well as within each respective procedural group, with Independent-Samples t-tests, Pearson's chi-squared tests, and Fischer's exact tests (expected values < 5). T-tests were utilized to identify differences in mean operative times between the inpatient and outpatient patient cohorts, while the chi-squared tests/Fischer's exact tests were utilized to calculate differences in demographics & preoperative comorbidities (i.e. race, sex, diabetes mellitus, hypertension, etc.).

All statistically significant differences in patient demographics and preoperative comorbidities were controlled for through propensity-score matching in a randomized 1:1 manner without replacement, with the exception of olecranon fracture repair; these patients were matched in a 4:1 manner due to the smaller sample size. The caliber was set at 0.2, and the propensity-generated cohort of inpatient procedures was subsequently compared to those of the outpatient cohort for any differences. Univariate analyses were utilized in assessing differences between the two groups. All statistical findings with p-values less than or equal to 0.05 were considered significant in this analysis. Specific demographic factors and comorbidities with statistically significant differences in rates between inpatient and outpatient cohorts were controlled for by generating multivariate logistic regression models. Propensity-score matching was completed using R© (2017) and IBM ® SPSS® Statistics Version 25 software. (IBM Corporation, Armonk, NY).

Multivariate logistic regression models were generated to assess outpatient surgeries as an independent risk factor for adverse outcomes (i.e. complications, reoperation, extended length of stay ≥5 days (LOS), readmission, & mortality) in comparison to inpatient surgeries. This study defined "minor complications" as transfusions, pneumonia, wound dehiscence, urinary tract infection, renal insufficiency, and superficial surgical site infection (SSI). "Major complications" were defined as including deep incisional SSI, organ space SSI, unplanned intubation, pulmonary embolism, failure to wean (on ventilator > 48 h), renal failure, stroke, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, deep venous thromboembolism, systemic sepsis, septic shock, reoperation, death, extended LOS, and readmission. Multivariate logistic regressions assessing outpatient surgery as a risk factor for adverse outcomes were not generated for THA, lumbar fusion, and olecranon fracture fixation, since both procedures had patients without statistically significant differences in demographic factors or preoperative comorbidities when stratified by inpatient/outpatient status. In these instances, chi-squared and Fischer's exact tests were utilized to assess differences in complication rates.

Multivariate logistic regression models were generated to assess longer operative times as an independent risk factor for adverse events (i.e. complications, reoperation, extended LOS, readmission, & mortality) for the various procedures. Longer operative times were defined as those in the 75th percentile for each respective procedure length. These multivariate analyses controlled for significantly different demographics and preoperative comorbidities when stratified into those with longer operative times and those without. All statistical analyses were performed using the IBM® SPSS® Statistics Version 25 software. (IBM Corporation, Armonk, NY).

3. Results

Inpatient orthopaedic procedures generally demonstrated significantly longer aggregate operative times ($\bar{x}$ = 134.59 min) when compared to outpatient settings ($\bar{x}$ = 88.21 min; p < 0.001). Performing the examined procedures in the outpatient setting demonstrated a time-cost savings of $1716.06 (Table 1). Multivariate regression analyses demonstrated increased rates of major and minor complications, reoperation, extended LOS, and unplanned readmission in the inpatient setting when compared to the outpatient setting (p < 0.001) (Table 2). Longer operative times also increased the risk for the same aforementioned postoperative complications when taking the orthopaedic procedures in aggregate (p ≤ 0.001) (Table 2).

Of the procedures analyzed, TKA was one of two procedures that failed to demonstrate significant differences in mean operative times between inpatient and outpatient settings (93.94 min vs. 93.13 min; p = 0.506) (Appendix B). Outpatient TKAs compared to inpatient TKAs demonstrated increased risk of extended LOS (p = 0.042) (Appendix B), but multivariate analyses failed to demonstrate outpatient setting as a risk factor for major complications, minor complications, reoperation, readmission, and death (Appendix B). Longer operative times in TKA also failed to demonstrate an increased risk for major complications, minor complications, reoperation, extended LOS, and readmission (Appendix B).

THA also failed to demonstrate a significant difference in mean operative times between inpatient and outpatient care settings (92.16 min vs 90.89 min; p = 0.426) (Appendix C). THAs performed in the outpatient setting experienced higher rates of major complications (p = 0.021) and extended LOS (p = 0.018) (Appendix C). However, inpatient THAs experienced higher rates of minor complications (p = 0.014) (Appendix C). With regard to longer operative times in THA, longer operative times increased the risk of any complication (p < 0.001), major complications (p = 0.003), minor complications (p < 0.001), and extended LOS (p < 0.001) (Appendix C).

Inpatient ACL repairs and reconstructions demonstrated longer mean operative times compared to outpatient repairs (133.19 min vs 102.04 min; p < 0.001) for a time-cost difference of $1152.55 (Appendix D). Inpatient ACL repairs/reconstructions demonstrated increased risk for any complication (p = 0.014) (Appendix D). Longer operative times for ACL repairs demonstrated increased risk for any complication (p < 0.001), major complications (p = 0.001), reoperation (p = 0.003), and extended LOS (p = 0.005) (Appendix D).

Inpatient microdiscectomy procedures demonstrated longer mean operative times compared to outpatient settings (139.6 min vs 81.49; p < 0.001) for a time-cost difference of $2109 (Appendix E). Aside from mortality (p = 0.101), inpatient settings for microdiscectomies increased the risk for the remaining complications included in this analysis (p < 0.001) (Appendix E). Microdiscectomies that had longer operative times increased the risk for all complications (p < 0.001; death: p = 0.004) (Appendix E).

ACDF demonstrated a significant difference in mean operative times between inpatient and outpatient surgical settings (130.56 min vs 101.16 min; p < 0.001) yielding a time-cost difference of $1087.80 (Appendix F). ACDFs done in inpatient settings experienced increased risk for all complications (p < 0.001; death: p = 0.044) (Appendix F). Apart from death, longer operative times in ACDF increased the risk of the remaining complications in the postoperative period (p < 0.010; death: p = 0.240) (Appendix F).

One-level lumbar fusion procedures performed in inpatient settings demonstrated significantly longer operative times when compared to outpatient settings (206.59 min vs 138.55 min; p < 0.001) for a time-cost difference of $2517.48 (Appendix G). Lumbar fusion procedures done in the inpatient setting experienced significantly higher rates of any complication (p < 0.001), major complication (p < 0.001), minor complication (p < 0.001), and extended LOS (p < 0.001) when compared to the outpatient cohort (Appendix G). Longer operative times in one level lumbar fusions demonstrated significantly increased risk for any complication (p < 0.001), major complication (p < 0.001), minor complication (p < 0.001), reoperation (p = 0.021), and extended LOS (p < 0.001) (Appendix G).

With a time-cost difference of $537.98, distal radius procedures done in the inpatient setting were significantly longer than done in the outpatient setting (89.59 min vs 75.05 min; p < 0.001) (Appendix H). Inpatient distal radius procedures were associated with increased risks

Table 1

	Inpatient Procedures			Outpatient Procedures			P-Value	Time-Cost Difference
	Mean Procedure Time	Standard Deviation	Standard Error of Mean	Mean Procedure Time	Standard Deviation	Standard Error of Mean		
TKA	93.29	37.829	0.081	93.13	37.601	0.864	0.853	5.92
THA	93.13	40.343	0.112	90.89	38.328	1.085	**0.040**	82.88
ACDF	133.64	73.106	0.429	101.16	48.358	0.489	< **0.001**	1201.76
Lumbar Fusion	206.53	103.98	0.57	138.55	85.087	2.83	< **0.001**	2515.26
Olecranon	93.36	58.795	3.632	81.62	49.94	1.567	**0.003**	434.38
Microdiscectomy	141.31	84.131	0.398	82.6	42.468	0.225	< **0.001**	2172.27
ALL Procedures	109	63.641	0.094	88.21	46.056	0.163	< **0.001**	769.23
	Inpatient Procedures			Outpatient Procedures				
	Mean Procedure Time	Standard Deviation	Standard Error of Mean	Mean Procedure Time	Standard Deviation	Standard Error of Mean	P-Value	Time-Cost Difference
ACL Repair/Recon.	133.19	64.574	2.237	101.85	48.734	0.401	< **0.001**	1159.58
Distal Radius	89.59	60.356	2.403	75.78	41.932	0.489	< **0.001**	510.97
PROPENSITY MATCHED COHORTS								
	PM-Matched Inpatient Procedures			Outpatient Procedures				
	Mean Procedure Time	Standard Deviation	Standard Error of Mean	Mean Procedure Time	Standard Deviation	Standard Error of Mean	PM-Matched P-Value	PM-Matched Time-Cost Difference
TKA	93.94	37.473	0.861	93.13	37.601	0.864	0.506	29.97
THA	92.16	38.92	1.103	90.89	38.328	1.085	0.426	46.99
ACDF	130.56	70.059	0.708	101.16	48.358	0.489	< **0.001**	1087.8
Lumbar Fusion	206.59	104.079	3.462	138.55	85.087	2.83	< **0.001**	2517.48
Olecranon	94.43	59.339	3.76	81.62	49.94	1.567	< **0.001**	473.97
Microdiscectomy	139.6	83.62	0.442	82.6	42.468	0.225	< **0.001**	2109
ALL Procedures	134.59	80.25	0.354	88.21	46.056	0.163	< **0.001**	1716.06
	PM-Matched Outpatient Procedures			Inpatient Procedures				
	Mean Procedure Time	Standard Deviation	Standard Error of Mean	Mean Procedure Time	Standard Deviation	Standard Error of Mean	PM-Matched P-Value	PM-Matched Time-Cost Difference
ACL Repair/Recon.	102.04	44.941	1.557	133.19	64.574	2.237	< **0.001**	1152.55
Distal Radius	75.05	36.109	1.44	89.59	60.356	2.403	< **0.001**	537.98

for any complication ($p < 0.001$), major complication ($p < 0.001$), and extended LOS ($p < 0.001$) (Appendix H). Risks of death and readmission were not increased with longer operative times. Distal radius procedures with longer operative times demonstrated significantly increased risks for the same complications ($p < 0.005$) (Appendix H).

Inpatient olecranon fractures demonstrated significant differences in mean operative time between the inpatient and outpatient care settings (94.43 min vs 81.62 min; $p < 0.001$) with a time-cost difference of $473.97 (Appendix I). Olecranon fractures treated in the inpatient setting experienced significantly higher rates of any complication ($p < 0.001$), major complication ($p < 0.001$), and extended LOS (≥ 5 days) ($p < 0.001$) when compared to the outpatient cohort (Appendix I). With the exception of extended LOS ($p = 0.004$), olecranon fractures with longer operative times failed to demonstrate any associated increase in risk of any other complications (Appendix I).

4. Discussion

The use of large databases in orthopaedic research is increasing.[6–9] The large number of patients (536,274) included in this analysis is strength of this study, adding certainty behind the statistical calculations. Also, because the ACS-NSQIP is a national database, the findings in this study are more likely to be applicable to US providers regardless of geographical setting. As opposed to other databases which are more focused on billing purposes or large collections of insurance claims data, the NSQIP was specifically collected to improve surgical quality.[10] The data entered into NSQIP are by medically trained professionals as opposed to other databases. The data is also reviewed by the NSQIP Data Definition Committee and interrater reliability disagreement is less than 1.8%.[10]

The ideal study to compare differences in operative times and outcomes for procedures performed in an outpatient or inpatient setting would be a randomized controlled study (RCT). However, in lieu of designing such an involved RCT, this database review, with its large volume of patients matched for medical co-morbidities and demographics, presents a reasonable alternative from which to draw conclusions.

Orthopaedic research utilizing large national databases come with inherent risks. Recent research has demonstrated that the same clinical question, when posed to different databases, may result in differing results.[6,11] Research utilizing databases is also inherently retrospective in nature. The NSQIP only captures data within the 30 days immediately postoperatively, limiting the inclusion of adverse events occurring outside this window. Databases allow for large n-values which may determine small but statistically significant differences. However, the reader must make the distinction whether these statistically significant differences represent clinically relevant findings. The NSQIP was designed for surgeon use and its outcomes are not specific to orthopaedic surgery. Although adverse events are critical in determining patient outcome, satisfaction, range of motion, and pain are additional important factors in orthopaedics and are not included in the NSQIP.[7]

All procedures in our sample indicated faster operative times in the outpatient setting except for total knee and hip replacements. This suggests that there are significant potential cost savings to be realized if policymakers and providers place a greater emphasis on performing elective orthopaedic procedures in an outpatient setting. On average, the cost savings are $1716.06 per procedure with the greatest statistically significant differential in one-level lumbar fusions ($2517.48) and

Table 2
All orthopaedic procedures.

	Mean Operative Time	SD	SE of Mean
PM-Matched Inpatient	134.59	80.25	0.354
Outpatient	88.21	46.056	0.163
P-Value	< **0.001**		
Time-Cost Difference	$ 1716.06		

	Odds Ratio	95% CI		P-Value
Any Complication	0.276	0.263	0.289	< **0.001**
Major Complication	0.290	0.276	0.305	< **0.001**
Minor Complication	0.237	0.219	0.257	< **0.001**
Reoperation	0.649	0.593	0.711	< **0.001**
Extended LOS (≥5 days)	0.079	0.071	0.087	< **0.001**
Readmission	0.762	0.710	0.819	< **0.001**
Death[a]	0.633	0.400	1.002	0.051

	Odds Ratio	95% CI		P-Value
Any Complication	4.015	3.848	4.189	< **0.001**
Major Complication	3.676	3.510	3.849	< **0.001**
Minor Complication	5.250	4.908	5.616	< **0.001**
Reoperation	1.669	1.515	1.839	< **0.001**
Readmission	7.125	6.707	7.570	< **0.001**
Extended LOS (≥5 days)	1.403	1.295	1.519	< **0.001**
Death	2.275	1.430	3.622	**0.001**

[a]Multivariate Analyzing **Outpatient Procedure** as Risk Factor Compared to Inpatient Procedure in Major Orthopaedic Procedures.
[b]Multivariate Analyzing **Longer Operative Time** as Risk Factor for Complications in Major Orthopaedic Procedures.
[a] Controlled for age, hypertension, wound infection, anesthesia type, ASA class.
[b] Controlled for age, sex, BMI, diabetes mellitus, smoking, COPD, CHF, hypertension, disseminated cancer, steroid use, anesthesia type, ASA class.

the smallest statistically significant differential in olecranon fracture fixation ($473.93).

The lack of statistically significant operative time differences between inpatient and outpatient total joint replacements can perhaps be explained by the unique payment structure to providers for these procedures. Health insurers, including Medicare, have largely transitioned from fee-for-service reimbursement to global payments intended to cover the entire episode of care over a 90-day period.[12] Providers make a profit if the total cost of care is less than the payment received from insurers and suffer a loss if the total cost of care is more expensive. With capitated payments, providers are incentivized to employ cost saving measures. This incentive would naturally drive inpatient providers to streamline operations such that the throughput of their total joint patients matches that of outpatient centers. This is reflected in operative times that are statistically equivocal. For procedures that are not covered under a global payments program, no such incentive for improving inpatient efficiency exists and thus the operative time and cost differences remain.

The analysis of outpatient setting as an independent risk factor for complications, re-operations, extended LOS, and readmission show that, in aggregate, procedures performed in an outpatient setting have better outcomes (e.g. lower odds ratios) after controlling for patient comorbidities and demographics. With the exception of ACDFs, which did show statistically significantly lower odds, procedures in an outpatient setting did not affect the odds ratio for mortality. Looking at this analysis for each procedure individually presents interesting findings. Paradoxically, with TKA we find that there are increased odds of having an extended LOS when the procedure is performed in an outpatient setting. This finding is difficult to explain, and perhaps is anomalously statistically significant given the low R-squared value of the regression model. Similarly, with outpatient THAs we find that there are increased rates of having an extended LOS and a major complication but decreased rates of having a minor complication in the outpatient setting. An alternative explanation may be that when complications in outpatient total joints do occur, they are serious enough to require a longer LOS (e.g. infection requiring IV antibiotics). Future work via a RCT may prove beneficial in further delineating the impact of an outpatient setting on postoperative complications for THA and TKA.

Outpatient ACLs, distal radius fracture fixations, and olecranon fracture fixations have lower odds of a complication occurring compared to their inpatient counterparts. For olecranon and distal radius fractures, there are also lower odds of an extended LOS when fixation is performed on an outpatient basis. All spine procedures (i.e. microdiscectomies, ACDFs, and one-level lumbar fusions) have lower odds of complications, re-operations, and extended LOS in the outpatient setting. ACDFs and microdiscectomies also have statistically significantly lower odds of readmission, though the same is not true for one-level lumbar fusion.

The analysis of operative time as an independent risk factor for complications, re-operations, extended lengths of stay, readmission, and death show that, in aggregate, longer operative times result in worse outcomes (e.g. higher odds ratios) after controlling for patient comorbidities and demographics. However, with TKAs in particular, longer operative times did not result in any statistically significant change in odds ratios. For olecranon fractures, longer operative times were associated with higher odds of an extended LOS but not for any of the other outcome variables. This suggests that longer operative times are less of a detriment in TKAs and olecranon fractures. The opposite appears true for spine procedures. Longer operative times in microdiscectomies have higher odds ratios of complications, re-operations, re-admissions, and even death. Likewise, there are higher odds ratios of a negative outcome for longer operative times for ACDFs (excluding mortality) and one-level fusions (excluding mortality and readmission). For THA and ACL repairs, longer operative times increased the odds ratio of developing a complication or having an extended LOS. For THA, longer operative times were also associated with increased odds of reoperation.

5. Conclusion and implications

Hospital care in the US is becoming increasingly more expensive, and without changes to the funding structure, Medicare will be unable to fully cover inpatient costs as soon as 2026. All stakeholders – insurers, providers, and patients – must search for lower-cost care strategies to build a more sustainable health system. One such strategy may be to encourage more elective orthopaedic procedures to be done on an outpatient basis, or alternatively to incentivize inpatient providers to be as streamlined and efficient as their outpatient counterparts. Our study shows that doing so would result in cost savings of $1716.06 per procedure due to shorter operative times.

Future research might focus on subdividing the outpatient surgery setting into ambulatory surgery centers (ASCs) versus hospital outpatient departments (HOPDs) and to perform a similar comparative analysis of operative times, costs, and quality outcome measures. Unfortunately, such a subdivision was not possible using the ACS-NSQIP database, but the implications from such an analysis could be far-reaching. If operative times in ASCs are shorter, then policymakers should potentially push for ASCs as the ideal operative setting in order to save the health system costs. Such a policy focus could represent a win for all stakeholders. Insurers such as Medicaid and Medicare would save money. Given the high rate of physician-ownership in ASCs, surgeons would assume more responsibility for patient care and gain financially from earning both facility and professional fees.[13] Most importantly, patients would benefit from having shorter procedures with better outcomes. Global payments may represent one way of incentivizing inpatient providers to perform more effectively as evidenced by the lack of a statistically significant difference in operative times between total joint replacements in the outpatient versus inpatient setting.

This paper suggests that a shift to more elective outpatient

procedures would not compromise quality of care; in fact, it may potentially improve quality, given the lower odds ratios of developing adverse patient outcomes in the outpatient setting with shorter operative times.

IRB approval statement

This study was exempt from Institutional Review Board approval as the ACS-NSQIP database is a nationally publicly available database of de-identified patient information.

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Appendix K. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jor.2019.09.012.

Appendix A

Procedure	CPT Codes
TKA	27447
THA	27130
ACDF	22551, 22554
Lumbar Fusion	22533, 22612, 22630, 22633
ACL Repair	29888
Olecranon	24685
Distal Radius	25607, 25608, 25609
Microdiscectomy	63030, 63012, 63042, 63047

TKA: Total knee arthroplasty; THA: total hip arthroplasty; ACDF: anterior cervical discectomy and fusion; ACL: anterior cruciate ligament.

Appendix B. Total Knee Arthroplasty

	Mean Operative Time	SD	SE of Mean
PM-Matched Inpatient	93.94	37.473	0.861
Outpatient	93.13	37.601	0.864
P-Value	0.506		
Time-Cost Difference	$ 29.97		

	P-Value	Odds Ratio	95% CI Odds Ratio	
Any Complication	0.132	0.238	0.037	1.539
Major Complication	0.118	4.506	0.683	29.740
Minor Complication	0.999	> 999.99	0.000	–
Reoperation	0.173	> 999.99	0.000	–
Extended LOS (≥5 days)	**0.042**	7.813	1.075	56.773
Readmission	0.054	0.077	0.006	1.046
Death[a]	1.000	0.940	0.000	–

	P-Value	Odds Ratio	95% CI	
Any Complication	0.535	2.012	0.222	18.269
Major Complication	0.759	1.419	0.152	13.229
Minor Complication	0.065	1.040	1.025	1.056
Reoperation	0.771	1.014	0.978	1.050
Readmission	0.842	1.035	1.013	1.057
Extended LOS (≥5 days)	0.384	0.949	0.936	0.963
Death	0.539	1.069	0.974	1.172

[a]Multivariate Analyzing **Outpatient Procedure** as Risk Factor Compared to Inpatient Procedure in Total Knee Arthroplasty (TKA).
[b]Multivariate Regression Analyzing **Longer Operative Time** as Risk Factor for Complications in Total Knee Arthroplasty (TKA).
[a] Controlled for race, smoking history, steroid use, anesthesia type, ASA class.
[b] Controlled for age, sex, race, BMI, functional status, anesthesia type.

Appendix C. Total Hip Arthroplasty

	Mean Operative Time	SD	SE of Mean
PM-Matched Inpatient	92.16	38.92	1.103
Outpatient	90.89	38.328	1.085
P-Value	0.426		
Time-Cost Difference	$ 46.99		

	P-Value	% of Patients in Inpatient Setting w/Complication	% of Patients in Outpatient Setting w/Complication
Any Complication	0.655	14.85	1.308
Major Complication	**0.021**	8.83	1.766
Minor Complication	**0.014**	8.11	0.925
Reoperation	0.861	1.36	1.870
Extended LOS (≥5 days)	**0.018**	6.66	1.912
Readmission	0.697	2.33	1.840
Death[a]	–	0	–

	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	2.128	1.601	2.830
Major Complication	**0.003**	1.694	1.194	2.404
Minor Complication	< **0.001**	2.858	1.979	4.127
Reoperation	0.856	1.089	0.433	2.741
Extended LOS (≥5 days)	< **0.001**	2.160	1.467	3.182
Readmission	0.894	0.951	0.455	1.990
Death[a]	–	–	–	–

[a]Pearson Chi-Square Tests Analyzing Rates of Complications based on **Procedural Setting** in Total Hip Arthroplasty (THA).
[b]Multivariate Analyzing **Longer Operative Time** as Risk Factor for Complications in Total Hip Arthroplasty (THA).
[a] No significantly different demographics or preoperative comorbidities after propensity matching.
[b] Controlled for age, sex, race, BMI, diabetes mellitus, smoking history, hypertension, anesthesia type.

Appendix D. ACL Repair/Reconstruction

	Mean Operative Time	SD	SE of Mean
Inpatient	133.19	64.574	2.237
PM-Matched Outpatient	102.04	44.941	1.557
P-Value	< **0.001**		
Time-Cost Difference	$ 1152.55		

	P-Value	Odds Ratio	95% CI	
Any Complication	**0.014**	0.478	0.265	0.860
Major Complication	0.124	0.616	0.332	1.142
Minor Complication	0.999	0.000	0.000	–
Reoperation	0.710	0.830	0.312	2.210
Extended LOS (≥5 days)	0.022	0.170	0.037	0.776
Readmission	0.518	0.699	0.236	2.073
Death[a]	–	–	–	–

	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	2.784	1.568	4.943
Major Complication	**0.001**	2.859	1.539	5.311
Minor Complication	0.280	2.275	0.512	10.107
Reoperation	**0.003**	4.846	1.722	13.636
Extended LOS (≥5 days)	**0.005**	5.285	1.638	17.049
Readmission	0.109	2.460	0.819	7.389
Death[a]	–	–	–	–

[a]Multivariate Regression Analyzing **Outpatient Setting** as Risk Factor Compared to Inpatient Setting in ACL Repair/Reconstruction.
[b]Multivariate Regression Analyzing **Longer Operative Time** as Risk Factor for Complications in ACL Repair/Reconstruction.
[a] Controlled for smoking history, anesthesia type.
[b] Controlled for age, race, hematologic disorders, anesthesia type.

Appendix E. Microdiscectomy

	Mean Operative Time	SD	SE of Mean
PM-Matched Inpatient	139.6	83.62	0.442
Outpatient	82.6	42.468	0.225
P-Value	< **0.001**		
Time-Cost Difference	$ 2109.00		

	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	0.214	0.202	0.226
Major Complication	< **0.001**	0.229	0.215	0.243
Minor Complication	< **0.001**	0.177	0.160	0.195
Reoperation	< **0.001**	0.630	0.570	0.696
Extended LOS (≥5 days)	< **0.001**	0.037	0.032	0.043
Readmission	< **0.001**	0.764	0.704	0.828
Death	0.101	0.626	0.358	1.095

	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	4.909	4.673	5.158
Major Complication	< **0.001**	4.248	4.027	4.480
Minor Complication	< **0.001**	6.705	6.214	7.234
Reoperation	< **0.001**	1.579	1.409	1.770
Extended LOS (≥5 days)	< **0.001**	8.056	7.536	8.610
Readmission	< **0.001**	1.409	1.281	1.550
Death	**0.004**	2.309	1.305	4.086

[a]Multivariate Analyzing **Outpatient Procedure** as Risk Factor Compared to Inpatient Procedure in Microdiscectomy.
[b]Multivariate Analyzing **Longer Operative Time** as Risk Factor for Complications in Microdiscectomy.
[a] Controlled for age, ASA class.
[b] Controlled for age, sex, race, BMI, diabetes mellitus, smoking history, COPD, CHF, hypertension, wound infections, steroid use, anesthesia type, and ASA class.

Appendix F. Anterior Cervical Discectomy and Fusion (ACDF)

	Mean Operative Time	SD	SE of Mean	
PM-Matched Inpatient	130.56	70.059	0.708	
Outpatient	101.16	48.358	0.489	
P-Value	< **0.001**			
Time-Cost Difference	$ 1087.80			
	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	0.355	0.308	0.410
Major Complication	< **0.001**	0.333	0.286	0.388
Minor Complication	< **0.001**	0.425	0.316	0.571
Reoperation	< **0.001**	0.476	0.343	0.662
Extended LOS (≥5 days)	< **0.001**	0.072	0.049	0.107
Readmission	< **0.001**	0.668	0.551	0.810
Death	**0.044**	0.269	0.075	0.965
	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	2.610	2.257	3.019
Major Complication	< **0.001**	2.765	2.377	3.217
Minor Complication	< **0.001**	2.714	2.014	3.655
Reoperation	**0.009**	1.644	1.130	2.390
Extended LOS (≥5 days)	< **0.001**	5.381	4.376	6.617
Readmission	**0.003**	1.434	1.127	1.824
Death	0.240	2.018	0.626	6.499

[a]Multivariate Analyzing **Outpatient Procedure** as Risk Factor Compared to Inpatient Procedure in ACDF.
[b]Multivariate Analyzing **Longer Operative Time** as Risk Factor for Complications in ACDF.
[a] Controlled for sex.
[b] Controlled for age, sex, race, BMI, diabetes mellitus, hypertension, ASA class.

Appendix G. Lumbar Fusions

	Mean Operative Time	SD	SE of Mean
PM-Matched Inpatient	139.6	83.62	0.442
Outpatient	82.6	42.468	0.225
P-Value	< **0.001**		
Time-Cost Difference	$ 2109.00		

	P-Value	% of Patients in Inpatient Setting	% of Patients in Outpatient Setting
Any Complication	< **0.001**	30.42	11.95
Major Complication	< **0.001**	24.00	8.74
Minor Complication	< **0.001**	13.50	6.31
Reoperation	0.165	4.20	2.99
Extended LOS (≥5 days)	< **0.001**	20.02	5.09
Readmission	0.696	3.54	3.21
Death	1.000	0.00	0.11

	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	6.085	4.553	8.133
Major Complication	< **0.001**	5.613	4.154	7.583
Minor Complication	< **0.001**	4.946	3.496	6.998
Reoperation	**0.021**	1.997	1.110	3.594

Extended LOS (≥5 days)	< **0.001**	7.508	5.442	10.359
Readmission	0.774	1.108	0.549	2.238
Death	0.994	0.000	0.000	–

[a]Pearson Chi-Square Tests Analyzing Rates of Complications based on **Procedural Setting** in Lumbar Fusions.
[b]Multivariate Regression Analyzing **Longer Operative Time** as Risk Factor for Complications in Lumbar Fusions.
[a] No differences amongst preoperative demographics and comorbidities after propensity matching.
[b] Controlled for BMI, diabetes mellitus, hypertension, ASA class, functional status.

Appendix H. Distal Radius

	Mean Operative Time	SD	SE of Mean	
Inpatient	89.59	60.356	2.403	
PM-Matched Outpatient	75.05	36.109	1.44	
P-Value	< **0.001**			
Time-Cost Difference	$ 537.98			
	P-Value	Odds Ratio	95% CI	
Any Complication	< **0.001**	0.354	0.205	0.611
Major Complication	< **0.001**	0.349	0.197	0.619
Minor Complication	0.418	0.558	0.136	2.290
Reoperation	0.169	0.517	0.202	1.323
Extended LOS (≥5 days)	< **0.001**	0.062	0.015	0.263
Readmission	0.662	0.817	0.331	2.021
Death[a]	0.991	0.000	0.000	–
	P-Value	Odds Ratio	95% CI	
Any Complication	**0.004**	2.108	1.276	3.482
Major Complication	**0.004**	2.172	1.289	3.662
Minor Complication	0.527	1.535	0.407	5.794
Reoperation	0.215	1.766	0.719	4.340
Extended LOS (≥5 days)	**0.001**	3.413	1.708	6.820
Readmission	0.839	0.892	0.295	2.695
Death[a]	0.994	0.000	0.000	–

[a]Multivariate Analyzing **Inpatient Procedure** as Risk Factor Compared to Outpatient Procedure in Distal Radius.
[b]Multivariate Analyzing **Longer Operative Time** as Risk Factor for Complications in Distal Radius.
[a] Controlled for functional status, COPD, wound infection, hematologic disorders, preoperative sepsis, anesthesia type, ASA class.
[b] Controlled for age, sex, BMI, COPD, anesthesia type.

Appendix I. Olecranon Fractures

	Mean Operative Time	SD	SE of Mean	
PM-Matched Inpatient	94.43	59.339	3.76	
Outpatient	78.29	37.523	2.397	
P-Value	< **0.001**			
Time-Cost Difference	$ 597.18			
	% of Patients in Inpatient Setting w/Complication	% of Patients in Outpatient Setting w/Complication		P-Value
Any Complication	18.88	5.71		< **0.001**
Major Complication	17.27	4.08		< **0.001**
Minor Complication	4.42	2.45		0.230
Reoperation	3.61	1.63		0.169
Extended LOS (≥5 days)	10.44	0.41		< **0.001**
Readmission	5.62	2.86		0.128
Death	0.40	0.00		1.000
	P-Value	Odds Ratio	95% CI	
Any Complication	0.181	1.631	0.796	3.341
Major Complication	0.128	1.787	0.846	3.774
Minor Complication	0.293	1.882	0.579	6.113
Reoperation	0.999	0.999	0.214	4.652
Extended LOS (≥5 days)	**0.004**	4.246	1.593	11.313
Readmission	0.467	0.576	0.130	2.550
Death	0.997	0.000	0.000	–

[a]Pearson Chi-Square Test Analyzing Rates of Complications based on Procedural Setting in Olecranon Fracture Fixation.
[b]Multivariate Regression Analyzing **Longer Operative Time** as Risk Factor for Complications in Olecranon Fracture Fixation.
[a] No differences amongst preoperative demographics and comorbidities after propensity matching.
[b] Controlled for age, BMI.

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