ORIGINAL ARTICLE

Unicondylar knee arthroplasty in the inpatient vs. outpatient setting: Impact on process time

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ABSTRACT

Objective: There is a lack of research on the impact of transitioning inpatient procedures to the outpatient setting, specifically on process time. Unicondylar knee arthroplasty (UKA) presents an opportunity for further investigation as it is already in the early stages of transitioning to the outpatient setting.
Methods: This study analyzed the medical records of 1,075 patients who received UKA from a single surgeon (400 in the outpatient setting and 675 in the inpatient setting). Time in Pre-Op, surgery time, and time in post-anesthesia care unit (PACU) were recorded and compared between inpatient and outpatient settings using Ordinary Least Squares Regression models.
Results: Outpatient UKAs outperformed inpatient UKAs across two out of three process time variables even after controlling for comorbidities, social history, demographics, and surgery related characteristics. Actual surgery time was no different between the two settings.
Conclusions: This study demonstrated that UKA performed in the outpatient setting is associated substantial time savings preoperatively and postoperatively compared with cases performed in the inpatient setting. More research is needed to compare other outcome measures such as patient outcomes of UKA between the two settings. Implications beyond time savings should consider supply and human resources costs.

Key Words: Outpatient vs. inpatient, Transitioning to outpatient-centered care, Knee

1. INTRODUCTION

With the advancement of medical technology, surgical procedures have been shifting from the inpatient setting to the outpatient setting. This presents an opportunity to lower health care costs while maintaining the quality of care. Yet, few studies have examined the implications of transitioning surgical procedures from the inpatient to outpatient setting on process time.[1]

One procedure that is in the early stages of being performed in the outpatient setting is unicondylar knee arthroplasty (UKA). Performing UKAs in the outpatient setting presents many potential benefits. One of the most appealing factors that patients experience from outpatient UKAs is that they are discharged home the same day as the surgery, thus eliminating hospital stay.[2] There is less risk of exposure to facility-borne infections as patients spend less time in the

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facility. Significant factors in the inpatient setting may include overhead of the entire hospital, staffing, equipment, and infrastructure costs.[3] The costs in the outpatient setting are reduced because there is less overhead associated with performing the surgeries, which in turn leads to less cost shifting.[4]

The process time of surgeries has not been widely compared between the outpatient and inpatient setting.[4] Process time can be measured by total throughput time, which is the calculated time from entry into the pre-surgical unit until discharge from the post-anesthesia recovery ward. The process time of a surgical procedure has an impact on the costs incurred by the facility because of shortened overall time in the pre-surgical ward, operating room, and the post-anesthesia recovery ward.[5]

Significant gaps exist in the research when it comes to assessing the performance of UKAs in the outpatient as compared to the inpatient setting. In fact, researching all variations of knee procedure types (unicondylar, unicompartmental or partial) and knee procedures (arthroplasty or replacement) with respect to the transition from inpatient to outpatient surgery has not yielded a large number of peer-reviewed literature sources.[2,4,6] This study aimed to compare the process time of UKA performed in the inpatient and outpatient settings, including time in the ambulatory surgical unit (ASU) and Pre-Op, time in surgery, and time in post-anesthesia care (PACU) and identify patient, setting, and procedure-related factors that may be associated with process time. We hypothesized that the overall process time and all three individual components would be shorter for outpatient UKA than for inpatient UKA patients.

2. Data and methods

2.1 Data source

The outpatient and inpatient data are at the provider level, from one orthopedic surgery office in Orlando, FL. The outpatient and inpatient data were captured from the patients' electronic medical records (EMR), paper records using manual data extraction, physician notes, and from Microsoft Excel reports provided by a Central Florida multi-specialty free standing ambulatory surgery center and a Central Florida regional nonprofit community hospital.

A confidentiality agreement was signed in order to access the EMR systems. The facility provided a signed letter authorizing full use and analysis of the data. In addition, approval from the University Institutional Review Board (IRB) approval was attained.

2.2 Population studied

This study is a retrospective analysis of UKAs with dates of service between January 1, 2009 and December 31, 2014. The data consist of 400 patients having knee surgeries in the outpatient setting and 675 patients having knee surgeries in the inpatient setting. The sample size of 1,075 individuals that will be analyzed is the total population of UKA patients seen by the practice during this timeframe.

2.3 Measures

The independent variable of interest is the setting in which the UKA was performed. This variable denotes whether the UKA was performed in the outpatient setting or the inpatient setting. Other variables controlled for include: patient demographics (age, gender, race, marital status); social history (employment status, alcohol consumption, tobacco use, physical activity); year of surgery (2009-2014); knee replacement type (right, left, or both); and implant type (Biomet Oxford or Zimmer Zuk). The dependent variable, process time, includes time in ASU/Pre-Op, surgery time, and time in post-anesthesia care unit (PACU). Time in ASU/Pre-Op is measured as the difference between time of entry and time of exit from the ASU/Pre-Op area. Surgery time represents the time from surgeon incision to time of closure of the surgery site. The time in PACU is measured by calculating the difference of the time of entry into the PACU from the time of exit from the PACU.

2.4 Analysis

Chi-square tests for association were utilized for categorical variables to determine if there are differences in variables between outpatient and inpatient UKAs. Time in the ASU/Pre-Op was measured by calculating the difference from time of entry into ASU/Pre-Op to time of exit from ASU/Pre-Op. Time in surgery was calculated by subtracting the surgery start time from the surgery end time. Total is the time from patient entry into the ASU/Pre-Op until discharge from the PACU – to the floor for inpatients and back home for outpatients. Ordinary Least Squares (OLS) regression models were utilized to identify the relationship between continuous dependent variables (process time) and independent variables (control variables).[7,8]

3. Results

3.1 Descriptive statistics

Overall, the population was equally divided in terms of right/left knee replacement (see Table 1). Only 3 patients had both knees replaced. The most common type of implant was the Zimmer Zuk, with over 88% of patients opting for that implant. The majority of the patients were older than 65 (83%) white (93%) and married (80%), and were nearly

equally divided by gender (49% male). The majority of the population was not employed (85%), and were non-drinkers (62%) and non-smokers or former smokers (94%). There was a statistically significant difference in service setting for year of service, implant type, age, marital Status, alcohol consumption, tobacco use, and physical activity. There was not a statistically significant association between service setting and the following variables: knee being replaced, gender, race, and employment status.

The mean time in ASU/Pre-Op was 93.3 minutes for outpatient UKAs and 150.3 minutes for inpatient UKAs (see Figure 1). The mean time in ASU/Pre-Op for outpatient UKAs was nearly one hour less (57.1 minutes less) than the mean time in ASU/Pre-Op for inpatient UKAs.

Table 1. Demographics of sample

Variable	Total Sample		Outpatient		Inpatient		*p*-value
	N = 1,075	%/Mean	n = 400	%/Mean	n = 675	%/Mean	
Year of Service							
• 2009	83	7.70%	54	13.50%	29	4.30%	***
• 2010	80	7.40%	61	15.30%	19	2.80%	
• 2011	124	11.50%	70	17.50%	54	8.00%	
• 2012	177	16.50%	40	10.00%	137	20.30%	
• 2013	281	26.10%	87	21.80%	194	28.70%	
• 2014	330	30.70%	88	22.00%	242	35.90%	
Knee							
• Left	538	50.00%	212	53.00%	326	48.30%	
• Right	534	49.70%	188	47.00%	346	51.30%	
• Both	3	0.03%	0	0.00%	3	4.00%	
Implant							
• Biomet Oxford	124	11.50%	83	20.80%	41	6.10%	***
• Zimmer Zuk	951	88.50%	317	79.30%	634	93.90%	
Age							
• Mean	1,075	72	400	69.3	675	73.06	***
Gender							
• Male	506	48.80%	195	48.80%	311	46.10%	
• Female	569	51.20%	205	51.20%	364	53.90%	
Race							
• Not Specified	50	4.70%	21	5.30%	29	4.30%	
• White	1,001	93.10%	372	93.00%	629	93.20%	
• Black	24	22.00%	7	1.80%	17	2.50%	
Marital Status							
• Not Specified	5	5.00%	4	1.00%	1	0.10%	***
• Married	862	80.20%	336	84.00%	526	77.90%	
• Widowed	120	11.20%	23	5.80%	97	14.40%	
• Divorced	33	3.10%	12	3.00%	21	3.10%	
• Single	51	4.70%	23	5.80%	28	4.10%	
• Separated	4	0.40%	2	5.00%	2	0.30%	
Employment Status							
• Not Employed	916	85.20%	344	86.00%	572	84.70%	
• Full Time	81	7.50%	28	7.00%	53	7.90%	
• Part Time	78	7.30%	28	7.00%	50	7.40%	
Alcohol Consumption							
• No	667	62.00%	215	53.80%	452	67.00%	***
• Yes	408	38.00%	185	46.30%	223	33.00%	
Tobacco Use							
• No	741	68.90%	290	72.50%	451	66.80%	***
• Yes	60	5.60%	34	8.50%	26	3.90%	
• Former	274	25.50%	76	19.00%	198	29.30%	
Physical Activity							
• No	615	57.20%	207	51.70%	408	60.40%	***

Note. *** $p < .01$, ** $p < .05$, * $p < .10$; Outpatient compared to Inpatient, across variable categories

The mean surgery time was 69.6 minutes for an outpatient UKA and 68.2 minutes for an inpatient UKA (see Figure 1). The mean surgery time for inpatient UKAs was 1.4 minutes less than mean surgery time for outpatient UKAs.

The mean time in PACU was 66.33 minutes for outpatient UKAs and 144.33 minutes for inpatient UKAs (see Figure 1). The mean time in PACU for outpatient UKAs is over 1 hour (78 minutes) less than the mean time in PACU for inpatient UKAs.

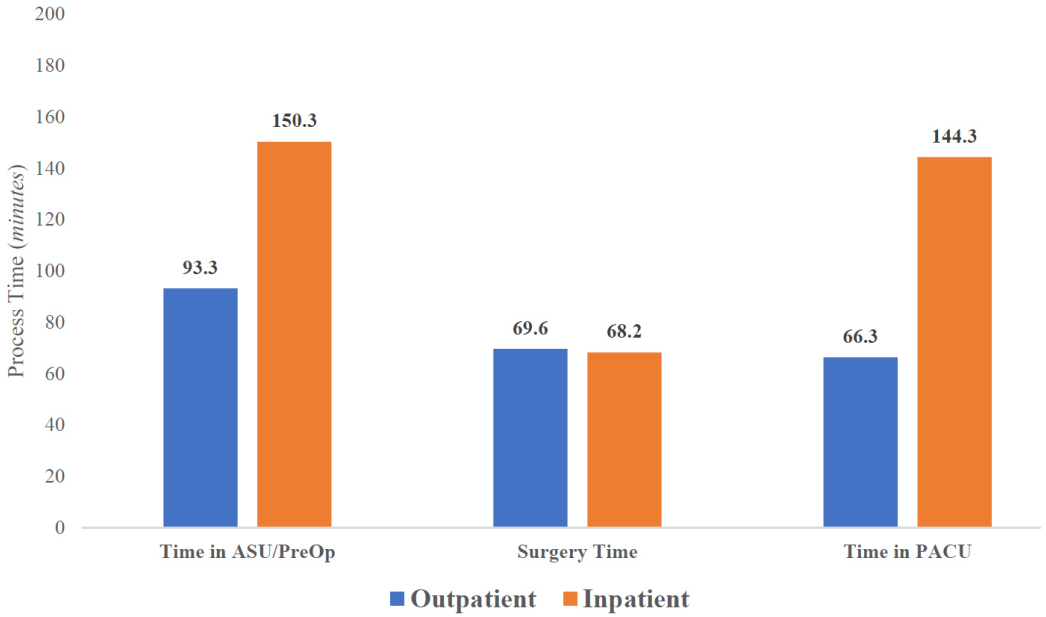

Figure 1. Average process times by setting (minutes)

3.2 Multivariate statistics

Process time

(1) Time in ambulatory surgery unit/Pre-Op

OLS coefficients for associations between demographics, service setting, and social history of the patients show a significant increase in time in ASU/Pre-Op for inpatient vs. outpatient surgical settings. Controlling for these independent variables the time in ASU/Pre-Op for inpatients was 49 minutes longer ($p < .001$) (see Table 2). Being widowed significantly increased time in ASU/Pre-Op by 11 minutes ($p = .011$) and being a former smoker decreased time by nearly 8 minutes ($p = .029$). While statistically significant, these may not be clinically meaningful.

(2) Surgery time

OLS coefficients for associations between demographics, service setting, and social history of the patients show a significant increase in time in surgery for inpatient vs. outpatient surgical settings. Controlling for these independent variables, the time in ASU/Pre-Op for inpatients was 5 minutes longer ($p < .001$). The most notable difference, although expected, was the fact that those patients receiving knee implants on both knees had an hour longer time in surgery than their counterparts only receiving one knee implant. Age significantly decreased time in surgery. In addition, female patients had a significantly shorter surgery time (2.5 minutes less than men, $p = .01$), although this may not be clinically meaningful. Black patients had a longer surgery time when compared to white patients (7 minutes longer, $p = .032$). Marital status, employment status, the type of implant received, tobacco use, physical activity, comorbidities, or alcohol consumption did not impact time in surgery (see Table 3).

(3) Time in PACU

OLS coefficients for associations between demographics, service setting, and social history of the patients show a significant increase in time in PACU for inpatient vs. outpatient surgical settings. Controlling for these independent variables, time in the inpatient setting is longer than the outpatient setting by approximately 78 minutes, although this is not statistically significant ($p = .091$) (see Table 4). Patients who had regular physical activity were associated with an approximate 10 minutes less time in the PACU ($p = .006$) when compared to those without.

4. Discussion

Overall the demographic characteristics of patients in our population were not markedly different for the inpatients and

the outpatients. The social history characteristics showed that most patients were nonsmokers, but it appears that current smokers may still be candidates for an outpatient UKA. A higher percentage of patients who are physically active do have the outpatient UKA as compared to the inpatient UKA. This is an interesting finding that could be further developed in future research with examining the relationship of health status and the choice of surgical location.

Table 2. OLS coefficients for time in ASU/Pre-Op

Covariates	Coefficient	SE	Sig.
Setting of Surgery			
• Inpatient	48.9	3.43	.000
• Outpatient	Reference		
Year of Service			
• 2009	-21.533	12.709	.091
• 2010	-19.787	8.487	.02
• 2011	-15.115	5.303	.004
• 2012	-6.257	4.601	.174
• 2013	18.126	4.044	.000
• 2014	Reference		
Knee			
• Left	Reference		
• Right	0.814	2.967	.784
• Both	8.721	28.05	.756
Implant			
• Biomet Oxford	Reference		
• Zimmer Zuk	12.673	10.952	.247
Age			
• Mean	0.059	0.227	.796
Gender			
• Male	Reference		
• Female	1.625	3.151	.606
Race			
• Not Specified	-6.678	7.33	.362
• White	Reference		
• Black	-13.797	10.145	.174
Marital Status			
• Not Specified	-20.06	22.117	.365
• Married	Reference		
• Widowed	12.767	5.02	.011
• Divorced	8.146	8.663	.347
• Single	4.103	7.23	.571
• Separated	19.419	24.528	.429
Employment Status			
• Not Employed	Reference		
• Full Time	4.481	6.238	.473
• Part Time	-6.471	5.821	.267
Alcohol Consumption			
• No	Reference		
• Yes	5.104	3.184	.109
Tobacco Use			
• No	Reference		
• Yes	2.667	6.629	.688
• Former	-7.892	3.62	.029
Physical Activity			
• No	Reference		
• Yes	-0.628	3.066	.838

Note. Dependent Variable is Time in ASU/Pre-op (ASU in to ASU out)

Table 3. OLS coefficients for time in surgery

Covariates	Coefficient	SE	Sig.
Setting of Surgery			
• Inpatient	5.045	1.065	.000
• Outpatient	Reference		
Year of Service			
• 2009	17.961	3.938	.000
• 2010	23.839	2.629	.000
• 2011	14.89	1.643	.000
• 2012	7.188	1.425	.000
• 2013	0.292	1.253	.816
• 2014	Reference		
Knee			
• Left	Reference		
• Right	-0.303	0.919	.741
• Both	61.491	8.69	.000
Implant			
• Biomet Oxford	Reference		
• Zimmer Zuk	-4.509	3.393	.184
Age			
• Mean	-0.183	0.07	.009
Gender			
• Male	Reference		
• Female	-2.504	0.976	.010
Race			
• Not Specified	3.401	2.271	.135
• White	Reference		
• Black	6.754	3.143	.032
Marital Status			
• Not Specified	3.401	2.271	.707
• Married	Reference		
• Widowed	2.579	2.684	.337
• Divorced	-0.256	2.24	.909
• Single	-9.495	7.599	.212
• Separated	6.754	3.143	.032
Employment Status			
• Not Employed	Reference		
• Full Time	1.316	1.933	.496
• Part Time	-2.581	1.803	.153
Alcohol Consumption			
• No	Reference		
• Yes	0.765	0.986	.438
Tobacco Use			
• No	Reference		
• Yes	3.703	2.054	.072
• Former	0.22	1.122	.845
Physical Activity			
• No	Reference		
• Yes	0.751	0.95	.430

Note. Dependent Variable is Time in Surgery (Surgery Start to Surgery Stop)

Patients having a UKA in the inpatient setting will, on average, spend approximately forty-nine minutes more in the ASU/Pre-Op than their outpatient counterparts. Inpatients are waiting longer in bed, hooked up to IVs, vital signs monitors, and oxygen, waiting to be taken to the operating room.[5] Besides the time factor, patients are taking up space and resources that can be used for other patients scheduled

for surgery that day.[2] As this time increases, a backlog of patients waiting for surgery in the ASU/Pre-Op causes more strain on the system.

Table 4. OLS coefficients for time in PACU

Covariates	Coefficient	SE	Sig.
Setting of Surgery			
• Inpatient	78.019	4.316	.091
• Outpatient	Reference		
Year of Service			
• 2009	28.428	15.962	.075
• 2010	22.53	10.659	.035
• 2011	24.145	6.661	.000
• 2012	34.407	5.779	.000
• 2013	7.298	5.079	.151
• 2014	Reference		
Knee			
• Left	Reference		
• Right	-5.395	3.726	.148
• Both	2.819	35.229	.936
Implant			
• Biomet Oxford	Reference		
• Zimmer Zuk	1.507	13.755	.913
Age			
• Mean	0.361	0.285	.206
Gender			
• Male	Reference		
• Female	4.217	3.957	.287
Race			
• Not Specified	4.967	9.206	.590
• White	Reference		
• Black	12.134	12.741	.341
Marital Status			
• Not Specified	-14.765	27.778	.595
• Married	Reference		
• Widowed	5.887	6.305	.351
• Divorced	5.583	10.88	.608
• Single	-3.596	9.08	.692
• Separated	-16.296	30.806	.597
Employment Status			
• Not Employed	Reference		
• Full Time	8.888	7.834	.257
• Part Time	-3.804	7.311	.603
Alcohol Consumption			
• No	Reference		
• Yes	-2.055	3.999	.607
Tobacco Use			
• No	Reference		
• Yes	-0.631	8.326	.940
• Former	-1.06	4.547	.816
Physical Activity			
• No	Reference		
• Yes	-10.636	3.85	.006

Note. Dependent Variable is Time in PACU (PACU in to PACU out)

Patients having a UKA in the outpatient setting will have approximately one minute more in surgery time than their inpatient counterparts. UKAs in the two settings generally utilize the same surgical technique and the same set of standard operating procedures for the surgery, however the inpatient setting will have a longer process time.[9] The UKA standard operating procedure involves the removal of the damaged tissue,[5,10,11] as well as multiple measurements taken throughout the surgery using guides and sizing pieces for the different components of the implant. However, the one minute difference may not, in the end, be financially or clinically meaningful to the patient, payer, or provider. This may be an area of future research to identify the granular differences, if any exist, in the surgery process in order to improve efficiency.[3]

Patients having a UKA in the inpatient setting will spend approximately 78 minutes more time in PACU than their outpatient counterparts. Although this was not statistically significant, this is clinically and financially significant. This additional time means that inpatients continue to receive intravenous medications, as well as vital signs monitoring in bed waiting to be admitted to the floor.[12] In other words, not only do the outpatients spend approximately one hour less in the PACU, they also are discharged to home. The time needed for the inpatient bed to be prepared and staffed to accept the patient after discharge from PACU may explain this large time gap.[4,13]

Patients having a UKA in the inpatient setting will have approximately 130.34 minutes more total process time than their outpatient counterparts. This study provided evidence that UKAs performed in the outpatient setting may result in time savings.

Overall, other studies conducted up to this point lacked analysis based on procedures transitioning to the outpatient setting. Most, if not all, surgical procedures were originally performed in an inpatient setting due to the lack medical techniques, level of technology support, safety concerns, and the ease of resource centralization.[13] In the inpatient setting contingencies were in place in case there were any types of complications during surgical procedures. However, with improvements in the field of medicine and safety, surgical procedures could be performed outside of the inpatient setting safely.[14,15] With outpatient services, hospitals are able to save on costs, due to less invasive procedures and reduced dependency on inpatient resources.[3] With the outpatient setting as a viable option, patients are discharged for recovery to their homes, instead of being admitted to the hospital. Nevertheless, given the wide variation in how procedures are performed and the supportive care that procedures require, transitioning to the outpatient setting is not a simple task that can be done on a large scale, especially given the current systems in place. Similarly, comparing performance measures of procedures across settings is not something that can be done on a wide scale. Each procedure must be evaluated

individually to identify how its intricate details are impacted by a move from the inpatient to the outpatient setting.

Although the healthcare system will benefit from this study, future research conducting a procedure-by-procedure approach will be needed to reveal the intricacies of the process time, quality outcomes, and patient satisfaction before a more widespread policy of transitioning procedures to the outpatient setting can be created. That step is necessary mainly due to the lack of wide-scale data that might offer direct comparisons for transitioning to the outpatient setting. Thus, the comparison of outpatient UKAs with inpatient UKAs functions as a stepping-stone in supporting an evidence-based approach to contrasting different procedures and treatments in both the outpatient and inpatient settings and across different variables. This study can be used as a platform for different national and international systems to transition their procedures to the outpatient setting.

There are other potential benefits that UKAs offer. For example, in countries where total knee arthroplasties (TKAs) are prohibitively expensive, or the post-operative care and rehabilitation is not available, UKAs could potentially become more common, especially in the outpatient setting.[16] As UKAs become more common, this study should be repeated in order to analyze surgical data from other physicians in the outpatient and inpatient settings.

The outpatient setting has been important in developing and testing new techniques to improve care.[10] Since physicians that work in freestanding facilities have more discretion and flexibility, they can develop and refine these techniques over time. Furthermore, physicians have more say in the policies and procedures that are used for surgeries in the outpatient setting, which allows for refinements of their techniques.[5,17] These new techniques range from performing different x-ray views, injecting pain medications into the tissue around the joint, requiring patients to walk the day of surgery, and participating in active physical therapy after surgery. The refinement process takes time, since there is an incentive for better outcomes and greater efficiency.[3] The findings of the current study are corroborated by previous studies showing that surgery time is shorter when the procedure is performed in the outpatient setting than the inpatient setting.[3,5]

Additionally, most freestanding ambulatory surgery centers are at least partially owned by physicians who perform surgeries at the facility.[18] Due to physician ownership interest, physician owners and physician-non-owners alike may have more stake in the profitability of the facility and there is a heightened incentive to control costs while reducing process time, increasing quality outcomes, and improving patient satisfaction.[10] In general, ambulatory surgery centers may be different from hospitals in three ways, physicians may select less severe patients to receive the procedure in the outpatient center, physicians may be incentivized to perform efficiently because physician owners not only receive professional fees, but also a share of the facility's profit, and ambulatory surgery centers tend to be specialized in performing a limited set of procedures. This study only focused on one surgical procedure - UKA - to compare outpatient and inpatient settings, both facilities are multi-specialty institutions. Additionally, factors that relate to severity of patients' health status were controlled for in this study to mitigate selection bias that could potentially take place.

Our results should be considered in light of several limitations. This study was dependent on data available from electronic medical records and reports provided by the orthopedic surgeon. Due to the fact that this study only analyzed one physician's patients (in one hospital for inpatients and one ambulatory surgery center for outpatients), external validity and generalizability of the study to other physicians and facilities may be limited.[3] The use of one physician's data, both for the outpatient and inpatient setting, minimizes issues of provider and operative consistency. This in turn strengthens the internal validity as the techniques of performing a UKA are essentially the same. It is important to note that these data were abstracted from the EMR, which resulted in imputation by the research team. This study does not show a causal relationship, it explored associations between time in ASU, surgery time, and time in the PACU and covariates, and the service setting in particular. Comorbidities and Body Mass Index (BMI) are two important factors that may affect surgery time. Although there was a lack of information related to these factors, this study controlled for age, tobacco, alcohol and physical activity, which may correlate with factors such as comorbidities and BMI.

5. CONCLUSIONS

After comparing outpatient UKAs with inpatient UKAs, the results showed differences, some of them statistically significant, with respect to Process Time. Overall, this study found that total time is approximately 130.34 minutes longer including time in ASU/Pre-Op, surgery time, and time in PACU for inpatients when compared to outpatients. These inefficiencies may have costs associated with them. In addition to time, hospital administrators should consider the impact of shifting procedures to outpatient venues on human resources and material costs. However, for patients who are good candidates for outpatient procedures the benefits of home based recovery cannot be underestimated.

CONFLICTS OF INTEREST DISCLOSURE

The authors declare they have no conflicts of interest.

REFERENCES

[1] Fulton LV, Lasdon LS, McDaniel RR Jr, et al. Including quality, access, and efficiency in healthcare cost models. Hospital Topics. 2008; 86(4): 3-17. PMid: 18922752. https://doi.org/10.3200/HTPS.86.4.3-17

[2] Berger R, Kusuma S, Sanders S, et al. The feasibility and perioperative complications of outpatient knee arthroplasty. Clinical Orthopaedics & Related Research. 2009; 467(6): 1443-1449. PMid: 19238499. https://doi.org/10.1007/s11999-009-0736-7

[3] Fabricant PD, Seeley MA, Rozell JC, et al. Cost Savings From Utilization of an Ambulatory Surgery Center for Orthopaedic Day Surgery. Journal of The American Academy of Orthopaedic Surgeons. 2016; 24(12): 865-871. PMid: 27792057. https://doi.org/10.5435/JAAOS-D-15-00751

[4] Jamali A, Scott R, Rubash H, et al. Unicompartmental knee arthroplasty: past, present, and future. American Journal of Orthopedics. 2009; 38(1): 17-23. PMid: 19238263.

[5] Munnich EL, Parente ST. Procedures take less time at ambulatory surgery centers, keeping costs down and ability to meet demand up. Health Affairs. 2014; 33(5): 764-769. PMid: 24799572. https://doi.org/10.1377/hlthaff.2013.1281

[6] Larsen K, Hansen T, Søballe K, et al. Patient-reported outcome after fast-track knee arthroplasty. Knee Surgery, Sports Traumatology, Arthroscopy. 2012; 20(6): 1128-1135. PMid: 22349544. https://doi.org/10.1007/s00167-012-1919-4

[7] Alexopoulos E. Introduction to multivariate regression analysis. Hippokratia. 2010; 14(Suppl 1): 23-28. PMid: 21487487.

[8] Pohlmann JT, Leitner DW. A comparison of ordinary least squares and Logistic Regression. Ohio Journal of Science. 2003; 103(5): 118-125.

[9] Stieber JR, Brown K, Donald GD, et al. Anterior cervical decompression and fusion with plate fixation as an outpatient procedure. Spine Journal. 2005; 5(5): 503-507. PMid: 16153576. https://doi.org/10.1016/j.spinee.2005.01.011

[10] Borus T, Thornhill T. Unicompartmental knee arthroplasty. The Journal of The American Academy of Orthopaedic Surgeons. 2008; 16(1): 9-18. PMid: 18180388. https://doi.org/10.5435/00124635-200801000-00003

[11] Partial knee replacement is option for some patients: patients find quick return to normal activity. Same-Day Surgery. 2008; 32(3): 34-36.

[12] Haack D. Ambulante Chirurgie/stationsersetzende Leistungen [Outpatient surgery/substitution of inpatient services]. 2010; 12: 259-261.

[13] Gamotis PB, Dearmon VC, Doolittle NO, et al. Inpatient hospital setting vs outpatient satisfaction: a research study. AORN Journal. 1988; 47(6): 1421. https://doi.org/10.1016/S0001-2092(07)66318-2

[14] Browne J, Jamieson L, Lewsey J, et al. Case-mix & patients' reports of outcome in independent sector treatment centres: comparison with NHS providers. BMC Health Services Research. 2008; 8: 1-7. PMid: 18400096. https://doi.org/10.1186/1472-6963-8-78

[15] Kolisek F, McGrath M, Jessup N, et al. Comparison of outpatient versus inpatient total knee arthroplasty. Clinical Orthopaedics & Related Research. 2009; 467(6): 1438-1442.

[16] Kurtz S, Ong K, Lau E, et al. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. The Journal of Bone and Joint Surgery. American Volume. 2007; 89(4): 780-785. PMid: 17403800.

[17] Chukmaitov AS, Menachemi N, Brown LS, et al. A comparative study of quality outcomes in freestanding ambulatory surgery centers and hospital-based outpatient departments: 1997–2004. Health Services Research. 2008; 43(5p1): 1485-1504.

[18] Liu X. The effect of physician ownership on quality of care for outpatient procedures. Dissertation Abstracts International. 2013; 74.