Original Article
http://mjiri.iums.ac.ir
Medical Journal of the Islamic Republic of Iran (MJIRI)

Med J Islam Repub Iran. 2023 (1 Nov);37.116. https://doi.org/10.47176/mjiri.37.116

Predictive Factors for Length of Stay in Patients Undergoing Total Hip Arthroplasty: A Cross-Sectional Study

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Received: 9 Apr 2022 Published: 1 Nov 2023

Abstract

Background: Total hip arthroplasty (THA) is an effective surgery for patients with end-stage hip joint degenerative arthritis. This study aimed to determine peri-operative factors that impact the length of stay (LOS) and design a formula to predict LOS in patients undergoing THA.

Methods: This cross-sectional study was performed from September 2019 to January 2020. For this study, all patients who underwent THA over a period of 12 years since 2005 were included in the study. Data about the LOS and several variables including demographic variables, surgery-related variables, transfusion, intensive care unit (ICU) admission, past drug history, comorbidities, and laboratory data, were gathered. Qualitative variables are presented as numbers (%), and quantitative variables are presented as mean Mann± standard deviation. Mann Whitney test , Kruskal-Wallis test, and Spearman's rank correlation test were also used.

Results: A total of 524 patients were included in the study; 12 were excluded .261 (51%) were female and 251(49%) male. The mean age was 56.13±17.04 years. In the univariate analysis, the day of admission, surgery indication, transfusion, diabetes mellitus, oral anti-diabetic drugs, American Society of Anesthesiology (ASA) score, preoperative hemoglobin (Hb) level, and type of prosthesis showed significant relation with LOS. Significant variables entered to zero truncated negative binomial regression. Among them, the day of admission, ASA score, preoperative Hb level, and type of prosthesis showed significant relation with LOS ($P < 0.05$) and were used for model design.

Conclusion: Preoperative Hb level, ASA score, day of admission, and prosthesis type have an impact on LOS and can predict LOS in patients who are candidates for THA.

Keywords: Length of Stay, Prediction, Total Hip Arthroplasty

Conflicts of Interest: *None declared*
Funding: *This study was funded by the student research committee, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran.*

Cite this article as: Bolourinejad P, Motififard M, Kazemi naeini M, Saffari M, Salehi F, Rajabzade P, Lachinani A, Yazdani A, Kheradmand M, Nemati A. Predictive Factors for Length of Stay in Patients Undergoing Total Hip Arthroplasty: A Cross-Sectional Study. *Med J Islam Repub Iran.* 2023 (1 Nov);37:116. https://doi.org/10.47176/mjiri.37.116

Introduction

By aging the population and increasing life expectancy, there is more need for hip reconstructive methods (1). Total hip arthroplasty (THA) is a highly effective procedure in elderly patients with degenerative joint disease that improves their physical activity. Due to progress in device design and surgical techniques, it has become more popular among patients and orthopedic surgeons, resulting in resource expenditure and increasing the burden on health systems (2). Due to the importance of resource management and to reduce the load on the health system,

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↑What is "already known" in this topic:
Total hip arthroplasty is a procedure for end-stage hip disease. Longer hospital stays result in higher post-operative complications and increases in the costs for the patients and health system providers; Thus, reducing the length of stay became a goal for health systems.

→What this article adds:
We deduce that among several perioperative factors, day of admission, pre-operative Hb, type of prosthesis, and American Society of Anesthesiologists score had significant relation with LOS and can be used for the prediction of the LOS.

researchers focused on factors that can reduce the costs.

Several factors, such as prosthesis type and design, rehabilitation programs, and duration of patient stay, can influence the cost-effectiveness of THA. As public health officials increasingly encourage physicians and hospitals to afford high-quality care at an affordable cost, hospital length of stay (LOS) got more attention.

An unanticipated increase in hospital stay results in increased post-operative complications and charges for patients and health systems. Some studies have evaluated the influence of various variables on LOS (3-10). These variables consist of age, sex, comorbidities, transfusion, and some other socio-demographic factors. Despite evaluating many risk factors, few studies have examined a valuable association between the preoperative status of patients and clinical characteristics with LOS after THA, and there are many controversies among previous reports.

Finding the factors affecting LOS and reducing LOS is essential for health systems to manage future costs.

The present study aimed to determine the perioperative factors that impact LOS after THA and design the formula to predict LOS in patients undergoing THA.

Methods

Participant and setting

This was a cross-sectional study performed at Kashani Hospital a tertiary referral center in Isfahan, Iran, from September 2019 to January 2020. The sampling was done based on non-randomized and convenience methods. The inclusion criteria was THA operation in Kashani hospital in a period of 12 years since 2005. The exclusion criteria were incomplete hospital documents and patients who had passed to another hospital for medical reasons during admission. All surgeries were performed by three expert surgeons with more than ten years of experience in THA.

Variables

Demographic and medical information include age, gender, marital status, residential address, day of admission and discharge, day of surgery, type of surgery(primary or revision), the indication of surgery, type of prosthesis (cemented or cement-less), hemoglobin level before the surgery, transfusion during the hospital stay, comorbidities, type of anesthesia (general, spinal and epidural anesthesia), drug history, history of intensive care unit (ICU) admission after surgery and American society of anesthesiologists (ASA) score.

Definitions

Length of hospital stay (LOS) was defined as the number of nights from admission to discharge from the hospital.

ICU admission was divided into planned and unplanned groups. Planned ICU admission was defined by the decision of anesthesiologists to admit the patients to the ICU after surgery; this decision was made before the surgery, considering the patient's co-morbidities. Unplanned ICU admission was defined as admission to ICU after surgery due to the patient's general condition without previous decisions before the surgery.

The residential address was classified as Isfahan(the city in which the study was done), rural and urban areas of Isfahan, and other cities.

Bias

This study was at risk of reviewer bias. To prevent this condition, study investigators were educated by expert personnel in the hospital archive.

Statistical analysis and ethical approval

Descriptive statistics have been used to describe the conditions of the studied samples. A frequency percentage has been used for qualitative variables, and the mean and standard deviation indices of quantitative variables have been reported. Because the distribution of LOS variables is skewed distribution and was not normal, non-parametric tests have been used for univariate analyses to compare LOS distribution in different categories of qualitative variables, the Mann-Whitney test where only two groups exist, Kruskal-Wallis test where more than two groups exist. The nonparametric Spearman's rank correlation test was used to investigate the relation between LoS and quantitative variables.

Then the variables with significant p-values in univariate analysis were entered into the multivariable analysis stage, and zero truncated negative binomial was used. The model was appropriate for skewed data since we didn't have zero LoS numbers in our study. The LOS variable distribution is truncated to zero. This analysis was carried out using the VGAM package in R version 4.0.0, an open-source statistical software. The significance level was considered at 0.05.

The study's protocol was evaluated and approved by the School of Medicine institutional review board (grant number 194323).

Results

524 patients were enrolled in the study, and 12 were excluded from the analysis due to exclusion criteria. Of the remaining 512 patients, 261 (51%) were female and 251 (49%) were male. The mean age was 56.13±17.04 years.

There was no statistically significant relationship between age and LOS ($P > 0.05$). Preoperative hemoglobin level was significantly related to LOS (r = -0.17, $P < 0.0001$).

The drug history of the study participants was evaluated. Patients who received oral anti-diabetic agents had longer LOS (P=0.006). Other medications taken by patients included warfarin, insulin, steroids, anticonvulsants, clopidogrel, aspirin, and levothyroxine, which didn't have a significant relation with LOS ($P > 0.05$). The frequency distribution of drug history is shown in Table 1.

Comorbidities among patients were diabetes mellitus, asthma, seizure, thyroid disease, hepatitis B, and C. Among them, Diabetes mellitus showed a significant relation with LOS ($P = 0.010$), while other comorbidities didn't (Table 1).

Table 1. LOS among study variables

Variable	Descriptive	LOS	*P*-value
Sex			
Male	251 (49%)	8.54±4.29	0.372
Female	261 (51%)	9.09±5.15	
Residential status			
Isfahan city	276 (57.26%)	8.92±5.39	0.243
Around Isfahan	124 (25.72%)	8.87±4.35	
Other Cities Around	82 (17.01%)	8.88±3.58	
Marital status			0.464
Single	31 (6.15%)	9.00±3.88	
Married	473 (93.84%)	8.75±4.72	
Day of admission			<0.001*
Saturday	147 (28.7%)	8.84±4.64	
Sunday	128 (25%)	8.98±5.35	
Monday	126 (24.6%)	7.95±3.26	
Tuesday	70 (13.7%)	8.29±4.79	
Wednesday	12 (2.3%)	12.17±6.39	
Thursday	18 (3.5%)	13.56±6.52	
Friday	11 (2.1%)	8.55±1.75	
Day of Surgery			0.697
Saturday	12 (2.3%)	9.00±4.65	
Sunday	101 (19.7%)	9.02±4.64	
Monday	148 (28.9%)	8.74±3.91	
Tuesday	138 (27%)	8.58±5.06	
Wednesday	111 (21.7%)	9.06±5.56	
Thursday and Friday	0 (0%)	0	
Type of Surgery			0.424
Primary	450 (87.9%)	8.72±4.66	
Revision	62 (12.1%)	9.56±5.35	
Type of anesthesia			0.323
General	88 (17.32%)	8.99±4.30	
Spinal	269 (52.95%)	9.10±5.39	
Epidural	151 (29.72%)	8.23±3.68	
Indication of Surgery			< 0.001*
Osteoarthritis	278 (55.6%)	8.05±3.56	
DDH	24 (4.8%)	8.58±2.96	
Rheumatoid Arthritis	14 (2.8%)	8.43±2.31	
Intertrochanteric Fracture	6 (1.2%)	10.83±6.55	
Device Failure	59 (11.8%)	10.02±7.51	
Femoral Neck Fracture	119 (23.8%)	9.87±5.41	
Type of prosthesis			0.001*
Cemented	52 (11.2%)	10.50±6.22	
Cement-less	412 (88.8%)	8.53±4.02	
ASA score			0.001*
1	227 (46.61%)	8.12±3.36	
2	190 (39.01%)	8.94±5.22	
3	67 (13.75%)	10.46±6.49	
4	3 (0.61%)	10.67±4.04	
Transfusion			<0.001*
Yes	345 (68.86%)	9.37±5.31	
No	156 (31.13%)	7.69 ±3.03	
Comorbidities			
Diabetes Mellitus			0.010*
Yes	68 (13.3%)	9.55±5.99	
No	444 (86.7%)	8.71±4.54	
Hypertension			0.066
Yes	141 (27.5%)	9.22±4.66	
No	371 (72.5%)	8.67±4.79	
Asthma			0.086
Yes	13 (2.5%)	8.00±1.95	
No	499 (97.5%)	8.84±4.80	
Thyroid disease			0.064
Yes	10 (2%)	9.90±7.18	
No	502 (98%)	8.80±4.70	
Seizure			0.558
Yes	8 (1.6%)	7.88±2.94	
No	504 (98.4%)	8.84±4.78	
Hepatitis B			0.907
Yes	2 (4%)	7.50±0.70	
No	510 (96%)	8.83±4.76	
Hepatitis C			0.109
Yes	3 (0.6%)	16.33±8.32	
No	509 (99.4%)	8.78±4.70	
ICU admission			0.461
No	283 (55.2%)	8.69±4.74	
Planned	220 (42.9%)	9.07±4.89	
Unplanned	9 (1.7%)	7.44±2.87	

Data are presented as number (%) and mean ± standard deviation; LoS: length of stay, ICU: intensive care unit, DDH: developmental dislocation of the hip, $P < 0.05$ considered statistically significant.*: statistically significant.

As shown in Table 1, the surgery indications were osteoarthritis, rheumatoid arthritis, femoral neck fracture, intertrochanteric fracture, and previous device failure. Patients with intertrochanteric fracture had significantly

Table 2. Data regression model with significant P-value(zero truncated negative binomial regression)

Variable	*P*-value	Estimate	Standard error	IRR
(Intercept): 1	<0.001	2.59	0.20	
Day of admission (Wednesday)	0.004	0.34	0.12	1.40
Day of admission (Thursday)	<0.001	0.42	0.10	1.53
Prosthesis type	0.023	-0.14	0.06	0.86
ASA score	0.004	0.11	0.03	1.11
Transfusion	0.050	-0.09	0.04	0.90
Preoperative Hb	0.009	-0.03	0.01	0.96
(Intercept): 2	<0.001	3.12	0.26	

higher LOS than other indications ($P < 0.001$).

Day of admission showed a significant relation with LOS. Patients admitted to the hospital on Wednesday and Thursday had longer stays than those admitted on other days ($P < 0.05$). Day of surgery didn't show a significant relation with LOS ($P = 0.697$). Detailed data about the relation between the study variables and LOS are presented in Table 1 (the difference between the number of patients among variables is due to missing data that have been excluded from the analysis). Data with significant relationships have been entered into a regression model and significant data are shown in Table 2.

By considering the significant P-values in the truncated binomial regression model, the below formula is constructed.

$$LOS = e^{2.568+0.345(Wednesday)+0.426(Thursday)-0.142(prosthesis)+0.103(ASA\ score)-0.0307(Pre-operative\ Hb)+etc}$$

Discussion

The main finding of this study was that the factors, including the day of admission, type of prosthesis, ASA score, and pre-operative Hb, have a statistically significant relation with LOS and could be used to predict it.

We evaluate the relation between several peri-operative factors with LOS by uni-variate analysis, and variables with significant relation in uni-variate analysis entered the regression model to design the formula.

Table 2 shows the evaluation between significant factors of Table 1 with LOS in a truncated binomial regression model. By considering IRR for each variable, it was found that patients admitted on Wednesday and Thursday had longer LOS compared with patients admitted on other days of the weak, respectively. This finding can be explained by the fact that Friday is a public holiday in our country, and to reduce the LOS, patients should not be admitted to the hospital these days. However, it is not preventable for patients who are admitted to the emergency department due to trauma. Considering that weekends are different in different countries, it is suggested that patients should not be admitted in the days leading up to weekends. None of the previous studies mentioned this point. However, two studies have found a relation between the day of surgery and LOS. Rathi et al. showed that patients who underwent surgery on Thursday had a 15% longer stay than those who operated on Monday. This difference was not statistically significant (11). Another study by Hustel et al. found that patients who underwent surgery on Thursday had longer stays which was due to changes in rehabilitation programs (12).

Another Significant variable was the type of prosthesis. Patients with non-cemented prostheses had 14% less LOS compared with cemented prostheses. Cemented prostheses are primarily used in patients with poor bone stock and osteoporosis who probably have more comorbidities. In contrast with our study, Zimmerma et al. in their study evaluated the relationship between LOS and the type of prosthesis and revealed that the difference was not statistically significant (13).

As is shown in Table 2, the ASA score showed a significant relation with LOS. Foote et al. in a series of 675 consecutive patients, found that patients with ASA 3 or 4 were associated with a long hospital stay (6). In comparison, Hartog et al. study, which evaluates the factors associated with LOS in a fast-track setting, didn't find this relation (5). We found that for each score increase in ASA, LOS increased 11%. ASA is a quantitative index of health status and comorbidities.

Our results showed that patients who didn't receive allogeneic blood transfusions had a 10% reduction in their LOS. However, this reduction was not statistically significant ($P = 0.05$). it can be explained that lower preoperative Hb results in a higher transfusion rate, and transfusion can affect LOS through pre-operative Hb. Lo et al. evaluated the predictor of LOS in patients undergoing TKA in a retrospective study and found transfusion as a predictor of LOS (14).

In our study, LOS decreased by 4% for each level increase in pre-operative Hb level. Previous studies showed controversial results about the relation between Hb level and LOS. Monsef et al revealed that although there is a significant relation between Pre-operative Hb and the need for allogeneic blood transfusion, they didn't find this relation between Hb level and LOS (4). On the other hand, Mahadevan found a relation between a prolonged hospital stay and Pre-operative Hb level in a series of patients undergoing revision THA (15).

We also calculated the equation model for the prediction of LOS before hospital admission. Although it is difficult for the orthopedic surgeon to use it in daily practice, it shows the important factors that can affect the LOS, which is useful for healthcare decision-makers to anticipate future hospital beds for these patients.

The strength of this study is the long duration of data evaluation, which was more than previous studies in this field. All previous reports were less than 5 years old. Another strength point of this study was that it evaluates many more factors than previous reports. We also had some limitations; this was a cross-sectional study, and due

to a long period, some missing data have been excluded from the analysis. Future studies should focus on prospective multicenter studies to assess the formula's accuracy in another patient's series. Another limitation was that the focus of this study was on non-surgical factors. There are intraoperative factors such as surgeon experience, surgical approach ,soft tissue damage and duration of surgery that can affect LOS.

Conclusion

We deduce that perioperative factors, including the day of admission, pre-operative Hb, prosthesis type, and ASA score, have a significant impact on the LOS in patients undergoing THA. LOS can be reduced by manipulating these factors.

Acknowledgment

The authors of this study are thankful to the Kashani Hospital presidency for their cooperation during this project and to Khalilollah Aligholian for his kind help in data gathering.

Conflict of Interests

The authors declare that they have no competing interests.

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