# Costing total hip arthroplasty in a South African state tertiary hospital

**A R Sekeitto,** MB ChB, PDM, FC Orth (SA), MMed (Orth); **A A Aden,** MD, FCS (SA) Orth

*Division of Orthopaedic Surgery, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa*

***Corresponding author:*** *A R Sekeitto (sekeitto@yahoo.com)*

**Background.** Most South Africans depend on the public sector for health services. There is an increasing demand for arthroplasty in the public sector, but a paucity of academic data regarding its cost.
**Objectives.** To: (*i*) identify the factors that determine the cost of an uncomplicated primary hip arthroplasty; and (*ii*) make recommendations on cost optimisation.
**Methods.** This was a cross-sectional study. Patients who met the inclusion criteria had their hospital financial records reviewed from October 2015 to March 2017. Six cost centres were utilised: inpatient admission, theatre and anaesthesia, ambulatory, prosthesis, physiotherapy and blood bank. The data were statistically analysed.
**Results.** Fifty-five patients met the study inclusion criteria. Data were stratified into categories. Analysis of variance (ANOVA) was used to test the data, and significant differences were found in the prosthesis, inpatient admission and ambulatory cost centres at a 95% significance level. The least significant difference was used to test the ANOVA results that paired significant categories. No cost centre showed significance over the other categories. Data for the six cost centres were compared with the current literature and industry best practice. Eight recommendations are made.
**Conclusions.** The study showed that clinicians need to be aware of procedural costing in the current financial climate. There are still opportunities to optimise cost containment in the state sector.

*S Afr Med J* 2021;111(3):250-254. https://doi.org/10.7196/SAMJ.2021.v111i3.14931

Total hip arthroplasty (THA) has proved to be a life-improving procedure since its inception in the 1970s.[1] It is among the most cost-effective interventions in medicine in terms of cost per quality-adjusted life-years gained.[2] According to the 2016 South African National Joint Registry Annual Report,[3] 47.6% of all entries from December 2012 to December 2015 were primary THAs.[3] In South Africa (SA), the ageing population has increased the demand for arthroplasty services in keeping with global trends referred to as an impending epidemic.[1,4-7] The public sector, which provides healthcare to 84% of the SA population, is under the spotlight with regard to arthroplasty waiting lists.[8] In light of the current budgetary constraints, there is a substantial economic burden associated with arthroplasty.[1,5,9]

Arthroplasty costs vary according to frequency of the procedure, varied inpatient services, availability of medical supplies, other treatment modalities utilised, and patient diversity.[10] Meyers *et al.*[10] found that the major cost drivers were the prosthesis, anaesthesia/operating room and nursing/hospital costs. They concluded that standardisation alongside development of critical pathways will reduce case-to-case variation and result in a substantial decrease in costs. Rana and William[6] showed that the above three factors made up 66% of total cost. The strongest correlation with total cost was hospital length of stay (LoS). However, they felt that this cost cannot be reduced further without compromising the quality of care.

Locally, the Gauteng Department of Health has developed initiatives to address surgical backlogs, particularly arthroplasty, by introducing a week-long blitz where arthroplasty patients are operated on during dedicated periods.[11,12] This week-long blitz, termed Move and Walk week, was launched at Helen Joseph Hospital (HJH) in October 2015, ushering in the first documented implementation of standardised procedures for arthroplasty in the public sector. This initiative, supported by development of a critical pathway through a multidisciplinary approach for perioperative management of these patients, entailed doing 25 - 30 operations in a week.[13]

Clinicians are generally not familiar with costs of patient care. An SA study showed that providing information to clinicians on laboratory test costs led to a significant drop in numbers of tests requested and associated cost, saving as much as 36% per day.[14] Treating clinical teams' awareness of cost drivers in THA has been shown to improve cost-containment measures.[15]

## Objectives

To determine the cost of an uncomplicated primary THA in a public hospital, to identify its cost factors, and to make recommendations on cost optimisation.

## Methods

We conducted a cross-sectional study at HJH. The study population consisted of patients aged >18 years who underwent total primary hip arthroplasty during the Move and Walk weeks from October 2015 to March 2017. Patients who were operated on outside the Move and Walk weeks and those who had revision THA were excluded. The study was approved by the Human Research Ethics Committee of the University of the Witwatersrand (ref. no. M161147). Data were collected from hospital records and the Move and Walk weeks financial records.

Costs associated with THA were divided into six cost centres: inpatient admission, theatre and anaesthesia, ambulatory, prosthesis, physiotherapy and blood bank. These centres were derived from the financial audit of the Move and Walk weeks at HJH. The inpatient

cost was calculated from the daily admission rate multiplied by the number of admission days. The laboratory cost was calculated from the National Health Laboratory Service invoice of each patient. The prosthesis cost was determined from the invoice submitted by the respective implant companies. The blood bank service cost, which comprised type and screen fee, after-hours levy and cost of blood products issued, was derived from the invoice incurred by the patient. The theatre and anaesthesia cost, which covered the expenditure incurred during the perioperative period in theatre, was provided by the HJH finance department.

Data were analysed using descriptive statistics for the demographic data and cost variables. The cost of each cost centre was evaluated in ZAR. The statistical analysis of continuous variables was presented using means and standard deviations (SDs). Since the total cost is the sum of all the cost centres, the quantiles were used to classify cost variables into categories of high, medium and low for all cost centres. Quantiles represent a statistical categorisation of continuous variables based on the representation from the sample. These categories were then used to evaluate whether there were significant differences between the patients within these cost centres. Analysis of variance (ANOVA) was used to test whether there was any significant difference between the means of more than two independent groups. The results of the *F*-statistics and their corresponding 95% significance levels were displayed in tables. If a significant difference was found, the least significant difference (LSD), calculated from the results of the ANOVA, was used to test, at an overall 5% level of significance. The LSD tests which pairs of categories are significantly different from each other, when there are more than two categories.

## Results

Fifty-five patients met the inclusion criteria. There were 14 males (25.6%) and 41 females (74.6%), with an age range of 42 - 82 years (mean (SD) 62.9 (10.7) years). The side of the procedure was left in 20 cases (36.4%), and right in 35 (63.6%).

The mean (SD) LoS was 7.5 (2.4) days, with preoperative and postoperative LoS of 2.8 (1.8) days and 4.8 (2.0) days, respectively. The mean (SD) inpatient cost was ZAR13 721.24 (4 340.72), with a minimum and maximum of ZAR7 124.00 and ZAR28 496.00, respectively (Table 1).

The mean (SD) prosthesis cost was ZAR40 305.16 (9 501.11), with a minimum and maximum of ZAR30 000.00 and ZAR72 761.22, respectively. The variation in cost is explained by certain companies having predetermined set pricing agreements with the hospital while others did not. The theatre and anaesthesia cost was a predetermined amount of ZAR17 243.00, and it remained unchanged during the study period. No statistical analysis was performed on this cost centre. The ambulatory cost was inclusive of costs of X-rays, electrocardiograms (ECGs), consulting, laboratory investigations and intravenous fluids. The HJH finance department calculated a fixed amount of ZAR1 141.00 to cover the first three items. The mean (SD) laboratory cost was ZAR1 391.54 (248.89), with a minimum and maximum of ZAR1 156.60 and ZAR2 837.33, respectively. The physiotherapy cost was billed per session at ZAR105.00. Patients received a single session preoperatively, and two sessions per day from day 1 postoperatively until discharge. Table 1 illustrates that the mean (SD) cost was ZAR798.00 (9 269.30) with a minimum and maximum of ZAR420.00 and ZAR1 890.00, respectively. The blood bank mean (SD) cost was ZAR726.32 (1 164.85), with a minimum and maximum of ZAR320.31 and ZAR7 396.35, respectively (Table 1).

The total cost for primary THA was calculated from the sum of all the cost centres. The mean (SD) cost was ZAR74 185.25 (10 792.83), with a minimum and maximum of ZAR60 414.04 and ZAR110 598.62, respectively (Table 1). Fig. 1 illustrates the percentage contribution of each cost centre to the total cost.

Table 2 shows the cost centres in quantiles. Quantiles were used to classify all cost centres into high, medium and low categories, as shown in Table 3. These categories were then used to evaluate whether there were significant differences between patients.

ANOVA was used to test whether there was any significant difference between the three levels. The results of the *F*-statistics and their corresponding 95% significance levels are displayed in Table 4. Type I SS is the sum of square associated with rejecting

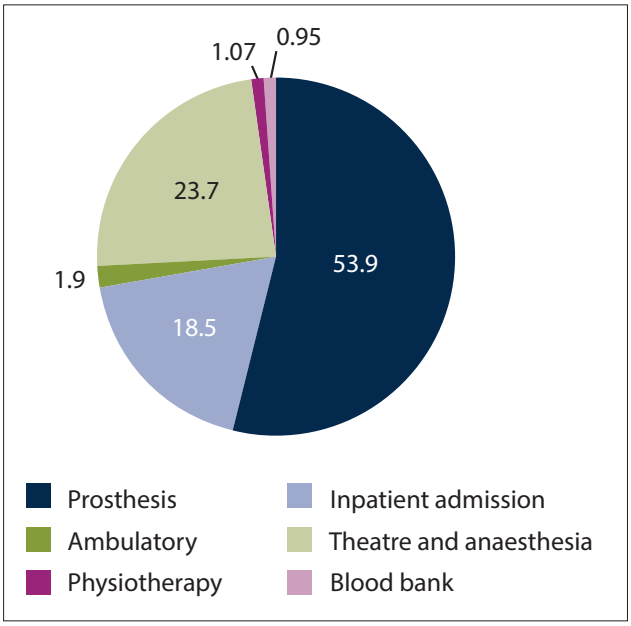


*Fig. 1. Contribution (%) of the six cost centres to the total cost of primary hip arthroplasty.*

**Table 1. Descriptive statistics of the respective cost centres**

| | Cost (ZAR) | | |
|---|---|---|---|
| **Cost centre** | **Mean (SD)** | **Minimum** | **Maximum** |
| Prosthesis | 40 305.16 (9 501.11) | 30 000.00 | 72 761.22 |
| Inpatient admission | 13 721.24 (4 340.72) | 7 124.00 | 28 496.00 |
| Ambulatory | 1 391.54 (248.89) | 1 156.60 | 2 837.33 |
| Theatre and anaesthesia | 17 243.00 (-) | 17 243.00 | 17 243.00 |
| Physiotherapy | 798.00 (269.30) | 420.00 | 1 890.00 |
| Blood bank | 726.32 (1 164.85) | 320.31 | 7 396.35 |
| Overall total cost | 74 185.25 (10 792.83) | 60 414.04 | 110 598.62 |

SD = standard deviation.

**Table 2. Quantiles of the cost centres**

| | Cost (ZAR) | | | |
|---|---|---|---|---|
| **Cost centre** | **Maximum** | **Q3** | **Q1** | **Minimum** |
| Prosthesis | 72 761.20 | 42 829.80 | 34 000.00 | 30 000.00 |
| Inpatient admission | 28 496.00 | 15 104.00 | 11 328.00 | 7 124.00 |
| Ambulatory | 2 837.33 | 1 373.96 | 1 297.14 | 1 156.60 |
| Physiotherapy | 1 890.00 | 840.00 | 630.00 | 420.00 |
| Blood bank | 7 396.35 | 709.01 | 320.31 | 320.31 |

Q = quantile.

**Table 3. Categories according to frequency**

| Cost centre | High, *n* (%) | Medium, *n* (%) | Low, *n* (%) |
|---|---|---|---|
| Prosthesis | 14 (25.5) | 27 (49.1) | 14 (25.5) |
| Inpatient | 14 (25.5) | 21 (38.2) | 20 (36.4) |
| Ambulatory | 14 (25.5) | 27 (49.1) | 14 (25.5) |
| Physiotherapy | 17 (30.9) | 19 (34.6) | 19 (34.6) |
| Blood bank | 14 (25.5) | 27 (49.1) | 14 (25.5) |

**Table 4. *F*-statistics of the cost centres**

| Cost centre | df | Type I SS | Mean square | *F*-value | *Pr*(>*F*) |
|---|---|---|---|---|---|
| Prosthesis | 2 | 3 887 318 824 | 1 943 659 412 | 86.93 | 0.0001* |
| Inpatient admission | 2 | 1 232 716 448 | 616 358 224 | 27.57 | 0.0001* |
| Ambulatory | 2 | 153 004 074 | 76 502 037 | 3.42 | 0.0416* |
| Physiotherapy | 2 | 5 674 515 | 2 837 258 | 0.13 | 0.8812 |
| Blood bank | 2 | 27 654 007 | 13 827 004 | 0.62 | 0.5434 |

df = degrees of freedom; Type 1 SS = sum of square associated with rejecting a true null hypothesis.
*Significant at the <0.05 level.

a true null hypothesis. The null hypothesis is that there is no significant difference between the categories of the cost centres. The overall model is significant, and it was found that there were some significant differences between the categories of prothesis cost centre, inpatient admission cost centre and ambulatory cost centre at a 95% significance level ($p<0.05$).

The LSD (Table 5), calculated from the results of the ANOVA, was used to test at an overall 5% level of significance, which pairs categories that differ significantly. The inpatient admission, prosthesis, ambulatory and physiotherapy cost centres showed significant differences between high and low, and between high and medium, categories, while there was no significant difference between low and medium categories. The blood bank cost centre showed a significant difference between high and low categories, and no significant differences between the low and medium, and high and medium, categories. However, the ambulatory cost centre demonstrated no significant differences between the categories.

## Discussion

The mean age of the patients was comparable to the reported age in the literature, as was mean LoS in hospital, despite the preoperative mean (SD) of 2.8 (1.8) days in our study.[16] The latter was required because of logistical constraints in the state sector, caused by the burden of trauma, to ensure availability of beds for these patients. Batsis *et al.*[17] have shown that LoS is a key determinant of resource utilisation,[17] hence the suggestion of proper postoperative streamlining of patients to reduce LoS. In fact, outpatient THA in appropriately selected patients has shown financial benefits when supported by clear perioperative protocols, with no increase in readmission or complications.[18-21] However, we are of the opinion that the SA public health system and patient population are currently not ready for outpatient THA.

The average prosthesis cost was ZAR40 305.20. However, since surgeons were allowed to use their preferred implant company, and some of the companies had no pre-set pricing with the hospital, this cost varied. This programme started before the Gauteng Province orthopaedic tender came into effect in 2017. Barber and Healy[22] found that the cost of the prosthesis amounted to 24% of the total inpatient cost, compared with 53.9% in our study. In the past decade, the price of a total hip prosthesis has risen by 212% in the USA, and variation of as much as 700% has been reported.[9,16] This trend does not follow the usual economies-of-scale principles, according to which the cost of the prosthesis should decline with increased numbers of procedures[22,23] – hence the need for standardisation recommended in many studies.[6,22,23] The theatre and anaesthesia cost was a fixed set amount during this study, and was therefore excluded from the statistical analysis. The ambulatory cost centre, which included investigations such as laboratory investigations, imaging and ECGs, as well as intravenous fluids, has already been standardised. The physiotherapy cost centre was not shown to be statistically significant, and we therefore offer no cost-containment recommendation. In the blood bank cost centre, our study showed that 25% of the patients ($n$=14) incurred an after-hours levy. We consider that this figure is too high, given the reported increased rate of allogenic blood transfusions after THA.[24]

In 2017, the private sector in SA implemented fixed global fee products to remunerate participating entities within total joint arthroplasty. Professional societies are opposed to this

**Table 5. Least squares means for the cost centres**

| Cost centre | Difference between means | 95% CL for LSMean(i) - LSMean(j) | *Pr*>\|t\| for H0: LSMean(i) = LSMean(j) |
|---|---|---|---|
| Prosthesis | | | |
| Category combination | | | |
| High - low | 19 974 | 14 818 - 25 130 | 0.0001* |
| High - medium | 18 911 | 14 418 - 23 403 | 0.0001* |
| Low - medium | –1 063.413968 | –5 555.846272 - 3 429 | 0.6368 |
| Inpatient admission | | | |
| Category combination | | | |
| High - low | 13 457 | 6 769.492089 - 20 145 | 0.0002* |
| High - medium | 9 719.479048 | 3 097.653853 - 16 341 | 0.0048* |
| Low - medium | –3 737.728667 | –9 734.046412 - 22 58.6 | 0.2166 |
| Ambulatory | | | |
| Category combination | | | |
| High - low | 8 107.377857 | 157.682782 - 16 057 | 0.0458* |
| High - medium | 6 972.997196 | 45.991906 - 13 900 | 0.0486* |
| Low - medium | –1 134.380661 | –8 061.385951 - 5 792.6 | 0.7438 |
| Physiotherapy | | | |
| Category combination | | | |
| High - low | 11 557 | 4 989.587194 - 18 124 | 0.0009* |
| High - medium | 8 858.847678 | 2 291.626668 - 15 426 | 0.0092* |
| Low - medium | –2 697.960526 | –9 080.152158 - 3 684.2 | 0.4002 |
| Blood bank | | | |
| Category combination | | | |
| High - low | 8 941.309286 | 980.150623 - 16 902 | 0.0285* |
| High - medium | 4 757.814233 | –2 179.17991 - 11 695 | 0.1746 |
| Low - medium | –4 183.495053 | –11 120 - 2 753.5 | 0.2317 |

CL = confidence limits; LSMean = least squares mean.
*Significant at the <0.05 level.

implementation, as it potentially leads to unethical conduct and a power imbalance driven by funders and facilities, and contravenes Health Professions Council of South Africa guidelines. The greatest risks to patients are underservicing and additional costs due to co-payments (Discovery Health, Advisory on global fee arrangement participation (press release), 2016 – unpublished).

In our study, the mean total cost of primary THA, which was ZAR74 185.25 with a minimum and maximum of ZAR60 414.04 and ZAR110 598.62, respectively, compares favourably with the cost in the private sector. Although our study did not calculate the cost of the surgical team and the anaesthetist, this figure is substantially lower than the cost in both the bundle-fee model and the fixed-fee model of the Discovery Health joint arthroplasty network, which were both ZAR133 262.00 in 2018 (Discovery Health, Elective hip and knee network agreement, 2017, and Joint arthroplasty agreement, 2018 – both unpublished). An interesting observation is the cost of the prosthesis in the private sector being limited to ZAR35 000.00 because of strong bargaining with implant companies, which was not the established protocol in our hospital. Moreover, the maximum physiotherapy cost in our study compares favourably with the private physiotherapy cost.

### Study limitations

Our study was limited by the small number of patients in comparison with other studies. It did not explore the relationship between indication for THA and impact on cost, which was shown to be a cost factor. We relied on the availability and adequacy of the financial data linked to patients undergoing THA, and we excluded the cost of chronic medication and overhead facility costs. Most of all, while our study collection ran over 3 years, no declaration was made about any inflationary adjustment.

### Recommendations

We recommend:

- Collective bargaining with implant companies to fix prosthesis cost.
- Reserving dedicated elective beds for rolling scheduled admissions for elective cases.
- Developing postoperative protocols in keeping with studies advocating for standardisation.
- Subdividing the theatre and anaesthesia cost centre into variables to obtain accurate figures.
- Respecting physicians' clinical autonomy regarding investigations to safeguard patient safety.
- Doing blood typing and screens the day before or on the morning of the procedure to avoid incurring an after-hours levy.
- Pro-rata estimation of the cost of the time spent by the surgical and anaesthetic teams to obtain comprehensive costing of THA in the public sector.
- Costing of all cost-driven procedures within orthopaedics.

## Conclusions

The demand for THA in SA is increasing in keeping with the global trend. The cost of healthcare services is coming under scrutiny owing to constrained budgets in the current financial climate. The private sector, however controversial, has been the forerunner in the

attempt to contain costs, and claims to have had success. Our study reviewed the literature and studied a cohort of arthroplasty patients in a local setting as well as the prevailing local industry practice. We analysed the six cost centres and provide eight recommendations for cost-containment measures on THA performed in the public sector.

**Declaration.** The research for this study was done in partial fulfilment of the requirements for ARS's MMed (Orthopaedic Surgery) degree at the University of the Witwatersrand.

**Acknowledgements.** We thank Virginia Gcaki, Dr Warren Meier, Lucia Mabuto, Stetson Haufiku and the Division of Orthopaedic Surgery for their support in completing this study.

**Author contributions.** ARS: substantial contributions to the conception and design of the work, and the acquisition, analysis and interpretation of data for the work; drafting the work and revising it critically for important intellectual content. AAA: substantial contributions to the conception and design of the work, and the acquisition, analysis and interpretation of data for the work; drafting the work and revising it critically for important intellectual content.

**Funding.** None.

**Conflicts of interest.** None.

1. Pivec R, Johnson AJ, Mears SC, Mont MA. Hip arthroplasty. Lancet 2012;380(9855):1768-1777. https://doi.org/10.1016/S0140-6736(12)60607-2
2. Daigle ME, Weinstein AM, Katz JN, Losina E. The cost-effectiveness of total joint arthroplasty: A systematic review of published literature. Best Pract Res Clin Rheumatol 2012;26(5):649-658. https://doi.org/10.1016/j.berh.2012.07.013
3. South African National Joint Registry. First Annual Report December 2012 - December 2015. 2016. http://www.centre-field.co.za/sanjr.org.za/index.html (accessed 12 May 2016).
4. Robinson JC, Pozen A, Tseng S, Bozic KJ. Variability in costs associated with total hip and knee replacement implants. J Bone Joint Surg 2012;94(18):1693-1698. https://doi.org/10.2106/JBJS.K.00355
5. Peel TN, Cheng AC, Liew D, et al. Direct hospital cost determinants following hip and knee arthroplasty. Arthritis Care Res (Hoboken) 2015;67(6):782-790. https://doi.org/10.1002/acr.22523
6. Rana AJ, William LH. Hospital economics of primary THA decreasing reimbursement and increasing cost, 1990 to 2008. Clin Orthop Relat Res 2011;469(2):355-361. https://doi.org/10.1007/s11999-010-1526-y
7. Molloy IB, Martin BI, Moschetti WE, Jevsevar DS. Effects of the length of stay on the cost of total knee and total hip arthroplasty from 2002 to 2013. J Bone Joint Surg 2017;99(5):402-407. https://doi.org/10.2106/JBJS.16.00019
8. Motsoaledi A, National Department of Health, South Africa. National Health Insurance (presentation to the Public Health Association of South Africa (PHASA) Conference, 12 September 2018). https://phm-sa.org/wp/wp-content/uploads/2018/09/Motsoaledi-2018-NHI-Presentation-PHASA-Conference.pdf (accessed 15 December 2018).
9. Gray CF, Bozic KJ. Epidemiology, cost, and health policy related to total knee arthroplasty. Curr Orthop Pract 2015;26(3):212-216. https://doi.org/10.1097/BCO.0000000000000229
10. Meyers SJ, Reuben JD, Cox DD, Watson M. Inpatient cost of primary total joint arthroplasty. J Arthroplasty 1996;11(3):281-285. https://doi.org/10.1016/s0883-5403(96)80079-9
11. South African Government. 2014/15 Gauteng health budget vote speech tabled by the MEC for Health Ms Qedani Mahlangu at Gauteng Provincial Legislature. 29 July 2014. http://www.gov.za/201415-gauteng-health-budget-vote-speech-tabled-mec-health-ms-qedani-mahlangu-gauteng-provincial (accessed 15 May 2016).
12. South African Government. Gauteng Health conducts arthroplasty and cataract procedure blitz, 5 to 9 Oct. 2 October 2015. http://www.gov.za/speeches/gauteng-health-address-surgical-backlogs-week-long-blitz-2-oct-2015-0000 (accessed 15 May 2016).
13. Solomons G. Week long operations blitz to address surgical backlogs. Soweto Urban, 6 October 2015. https://sowetourban.co.za/21522/week-long-operations-blitz-to-address-surgical-backlogs/ (accessed 6 August 2016).
14. Ellemdin S, Rheeder P, Soma P. Providing clinicians with information on laboratory test costs leads to reduction in hospital expenditure. S Afr Med J 2011;101(10):746-748.
15. Sommer LS, Schurman DJ, Jamison JQ, Woolson ST, Robinson BL, Silverman JF. Clinician-directed hospital cost management for total hip arthroplasty patients. Clin Orthop Relat Res 1990;258:168-175.
16. Antoniou J, Martineau PA, Filion KB, et al. In-hospital cost of total hip arthroplasty in Canada and the United States. J Bone Joint Surg 2004;86(11):2435-2439. https://doi.org/10.2106/00004623-200411000-00012
17. Batsis JA, Naessens JM, Keegan MT, Huddleston PM, Wagie AE, Huddleston JM. Resource utilisation of total knee arthroplasty patients cared for on specialty orthopedic surgery units. J Hosp Med 2008;3(3):218-227. https://doi.org/10.1002/jhm.299
18. Ayanardi M, Post Z, Orozeo F, Sukin DC. Outpatient surgery as a means of cost reduction in total hip arthroplasty: A case-control study. HSS J 2014;10(3):252-255. https://doi.org/10.1007/s11420-014-9401-0
19. Bertin KC. Minimally invasive outpatient total hip arthroplasty. Clin Orthop Relat Res 2005;435:154-163. https://doi.org/10.1097/01.blo.0000157173.22995.cf
20. Dorr LD, Thomas DJ, Zhu J, Dastane M, Chao L, Long WT. Outpatient total hip arthroplasty. J Arthroplasty 2010;25(4):501-506. https://doi.org/10.1016/j.arth.2009.06.005
21. Klein GR, Posner JM, Levine HB, Hartzband MA. Same day total hip arthroplasty performed at an ambulatory surgical center: 90-day complication rate on 549 patients. J Arthroplasty 2017;32(4):1103-1106. https://doi.org/10.1016/j.arth.2016.10.013
22. Barber TC, Healy WL. The hospital cost of total hip arthroplasty: A comparison between 1981 and 1990. J Bone Joint Surg 1993;75(3):321-325. https://doi.org/10.2106/00004623-199303000-00002
23. Nitin JB. Joint replacement costs in the era of healthcare reform. J Bone Joint Surg 2012;94(18):e140. https://doi.org/10.2106/JBJS.L.00778
24. Saleh A, Small T, Chandran Pillai AL, Schiltz NK, Klika AK, Barsoum WK. Allogenic blood transfusion following total hip arthroplasty: Results from the nationwide inpatient sample, 2000 to 2009. J Bone Joint Surg 2014;96(18):e155. https://doi.org/10.2106/JBJS.M.00825

*Accepted 15 October 2020.*