The cost of outpatient versus inpatient total hip arthroplasty: a randomized trial

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Presented at The Hip Society 2019 Summer Meeting, Sept. 25–27, 2019, Kohler, Wisc., the 20th European Federation of National Associations of Orthopaedics and Traumatology (EFORT) Annual Congress, June 5–7, 2019, Lisbon, Portugal, and the Canadian Orthopaedic Association 2020 Virtual Annual Meeting, June 19–20, 2020.

Accepted Nov. 10, 2021

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Cite as: *Can J Surg* 2022 September 1; 65(5). doi: 10.1503/cjs.003821

Background: One route to mitigate the increasing costs of total hip arthroplasty (THA) is outpatient THA, discharging patients on the same day as their surgery. The purpose of this study was to compare the cost of outpatient THA to standard overnight stay in hospital.

Methods: This was a preliminary analysis of the first group of patients to complete follow-up in a larger randomized controlled trial among patients who underwent primary THA through a direct anterior approach between June 2015 and November 2017. The study was conducted at a single centre among patients of 1 fellowship-trained arthroplasty surgeon. We randomly allocated participants to be discharged either as outpatients or on postsurgery day 1 using a modified Zelen consent model. Adverse events were recorded. Participants completed cost questionnaires 2, 6 and 12 weeks after surgery, and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) before and 12 weeks after surgery. We performed cost analyses from health care payer and societal perspectives.

Results: A total of 115 participants completed this study, 49 allocated to the outpatient group and 56 to the inpatient group. The adverse event rate was similar for the 2 groups. The WOMAC total score and function subscale score were higher for the outpatient group than the inpatient group at 12 weeks (mean difference 2.1, 95% confidence interval [CI] 0.0 to 4.1, and 6.5, 95% CI 0.4 to 12.5, respectively). From both a health care payer and a societal perspective, inpatient THA was more costly than outpatient THA (mean difference $1006.86, 95% CI –$2158.92 to $145.21, and $1667.40, 95% CI –$3856.64 to $521.84, respectively).

Conclusion: Our results suggest that outpatient THA may be a cost-saving procedure compared to inpatient THA from both health care payer and societal perspectives. Further study with larger samples is needed to provide more precision around our estimates. **Trial registration:** ClinicalTrials.gov, no. NCT03026764.

Contexte : Pour limiter l'accroissement des coûts de l'arthroplastie totale de la hanche (ATH), on pourrait entre autres effectuer l'intervention en externe, soit donner leur congé aux patients le jour même de l'intervention. Dans cette étude, le but était de comparer les coûts des ATH pratiquées sur des patients ambulatoires et sur des patients hospitalisés selon le traitement standard.

Méthodes : Nous présentons ici une analyse préliminaire du premier groupe de patients à avoir terminé la phase de suivi d'un essai clinique randomisé plus vaste mené auprès de patients ayant subi une ATH primaire par voie antérieure directe entre juin 2015 et novembre 2017. L'étude a été menée dans un seul centre, chez les patients d'un seul chirurgien spécialiste en arthroplastie. Les participants ont été répartis aléatoirement d'après un schéma de Zelen modifié, selon qu'ils recevaient leur congé postopératoire le jour de l'intervention ou le lendemain (jour 1). Les événements indésirables ont été notés. Les participants ont répondu à 2 séries de questionnaires : 1 questionnaire sur les coûts 2, 6 et 12 semaines après l'intervention chirurgicale; et l'indice Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) avant l'intervention chirurgicale et 12 semaines après. Nous avons effectué des analyses de coûts du point de vue sociétal et des régimes d'assurance maladie.

Résultats : Au total, 115 participants ont terminé l'étude; 49 faisaient partie du groupe des patients ambulatoires et 56, du groupe des patients hospitalisés. Les taux d'événements indésirables étaient semblables dans les 2 groupes. Après 12 semaines, le score total de l'indice WOMAC et les scores des sous-échelles fonctionnelles étaient plus élevés pour le groupe des patients ambulatoires que pour celui des patients hospitalisés (différence moyenne 2,1, intervalle de confiance [IC] de 95 % 0,0 à 4,1; et 6,5, IC de 95 % 0,4 à 12,5, respectivement). Du point de vue des régimes d'assurance

maladie et du point de vue sociétal, les coûts associés à l'ATH étaient plus élevés chez les patients hospitalisés que chez les patients ambulatoires (différence moyenne 1006,86$, IC de 95 % –2158,92$ à 145,21$; et 1667,40$, IC de 95 % –3856,64$ à 521,84$, respectivement).

Conclusion : D'après nos résultats, effectuer les ATH en externe permettrait de réduire les coûts, tant du point de vue sociétal que de celui des régimes d'assurance maladie. Il faudra cependant approfondir la recherche avec de plus grands échantillons pour préciser nos estimations. **Numéro d'enregistrement de la recherche :** ClinicalTrials.gov, nº NCT03026764.

Total hip arthroplasty (THA) is an effective surgical intervention for the treatment of advanced hip osteoarthritis. The number of these procedures performed in Canada increased by 17.8% between 2012/13 and 2016/17[1] and is expected to continue to rise. This increase affects health care budgets substantially. To mitigate the rising costs, some surgeons have introduced outpatient THA into their practice, whereby patients are discharged on the same day as their surgery. However, high-quality evidence to support the use of outpatient THA is lacking. Substantial cost savings are projected for outpatient procedures, as they eliminate the need for an overnight stay with the associated nursing, pharmacy and inpatient costs.[2,3]

Many studies have been published evaluating the safety of outpatient THA,[4–14] including several reviews of US national databases,[9–14] which have all shown outpatient THA to have complication rates similar to those of inpatient procedures. Most prospective studies of outpatient THA have included carefully selected patient populations[3,15–19] and used observational cohort designs,[4–7] thus limiting the generalizability and strength of the evidence. To our knowledge, only 1 study involved a randomized study design,[20] and, although this is an improvement from nonrandomized observational designs, there was substantial crossover between the groups, as the investigators allowed participants to switch groups based on personal preference.

Few authors have investigated cost savings,[2,3] and, to our knowledge, none have investigated costs prospectively in conjunction with a randomized trial. The 2 studies in which costs were investigated showed outpatient THA to be cost saving.[2,3] One of these studies was a pilot study comparing the cost for a prospective cohort of 10 outpatients to a matched cohort of inpatients.[2] The other study was also an observational case–control study, but it included 119 outpatients, all of whom underwent a direct anterior surgical approach.[3] Both studies investigated only direct costs of the procedures and costs incurred during the hospital stay, using a health care payer perspective.

Since safety is of highest concern when discharging patients earlier after surgery, costs associated with possible postoperative complications should be accounted for in cost analyses. Therefore, the purpose of the present study was to investigate the cost of outpatient THA compared to inpatient THA (standard overnight stay in hospital). We hypothesized that outpatient THA would have substantial cost savings compared to inpatient THA.

Methods

We conducted a randomized trial to compare patients discharged from hospital after THA as outpatients to those with standard overnight stay (inpatients). All patients underwent THA through a direct anterior surgical approach, which, at our institution, has a standard hospital length of stay of 1 day. All participants in this study were scheduled as the first or second case of the day to ensure that those allocated to the outpatient group could be discharged the same day as surgery. The postoperative analgesia regimen was as per standard of care and therefore kept the same for the 2 groups. This paper represents a preliminary analysis of patients who underwent surgery between June 2015 and November 2017. The study was conducted at a single centre among patients of 1 fellowship-trained arthroplasty surgeon. It was approved by our institution's research ethics board and registered at ClinicalTrials.gov (NCT03026764).

Selection criteria

Patients were included if they were scheduled to undergo primary THA with an American Society of Anesthesiologists status of 3 or less, were able to read and understand English, lived within a 60-minute driving distance of the hospital, had home telephone or cellphone access, and had an adult caregiver to accompany them home postoperatively. Patients were excluded if they had been diagnosed with fibromyalgia; were skeletally immature; had an active or suspected latent infection in or about the joint; had bone stock inadequate for support or fixation of the prosthesis; were unable to go to their home after surgery; had cognitive or neuromotor conditions, major pain-management issues, a family history of anesthesia-related complications, obesity that substantially affected their ability to mobilize, anaphylaxis to penicillin or major psychosocial issues that would prevent them from managing safely at home; or were narcotic dependent.

Randomization

Participants were enrolled at consultation for surgery and were randomly allocated to the outpatient group or the inpatient group via a Web-based randomization system a minimum of 3 months before surgery. Randomization was stratified by previous experience with THA (the patient him- or herself, or a family member he or she cared for postoperatively). We allocated the participants 1-to-1 to either outpatient or inpatient THA using a modified Zelen consent model[21] to minimize the risk of bias associated with knowledge of the alternative intervention. We used this model because we posited that patients with a strong preference for overnight care who were allocated to the outpatient group might have been more likely to return to seek additional care, which would bias costs substantially. Alternatively, allocation of patients with a strong preference for outpatient care to the inpatient group might have biased measures of satisfaction. Thus, for this study, we asked participants to consent to all aspects of the study protocol with the exception of random allocation; participants were not told about randomization, the existence of an alternative group or our between-group objectives. At the final study visit, we disclosed the full nature of the study to the participants and why blinded randomization was necessary, and sought consent to include their data in the analysis.

Outcome assessment

Assessments were completed before surgery, at discharge from the hospital, and 2, 6 and 12 weeks after surgery. Participants completed a self-reported cost questionnaire at all postsurgery visits, and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) before surgery and 12 weeks after surgery. The WOMAC is a patient-reported outcome measure used to measure function and includes pain, stiffness and function subscales, with higher scores indicating better function. It has been found to be valid for use in assessing patients undergoing hip arthroplasty.[22] Adverse events were recorded at each study visit, and surgical characteristics (including change in hemoglobin level, operative time and length of stay in hospital) were recorded.

Costs collected included visits to emergency departments, specialists, family doctor, outpatient clinics and other health care professionals (such as physical therapists and occupational therapists). We also collected information about hospital admissions, tests, procedures, additional operations, medications, and calls to the surgeon's office or resident on call. We obtained all direct costs from the Ontario Ministry of Health Schedule of Benefits,[23] and obtained medication costs from the Ontario Drug Benefit Formulary/Comparative Drug Index.[24] If patients reported that they paid for other health care professional visits out of pocket or via private insurance, we used their self-reported costs per visit.

We also collected information about indirect costs such as employment status and time off paid employment, homemaking and volunteer activities, as well as assistance received from friends or family (including caregivers who stayed with patients postoperatively) and their time off paid employment. To evaluate the cost related to time off paid employment, we used the self-reported annual household income to calculate the average wage per day and, using self-reported days off work, calculated the total wages lost. For our base-case analysis, we did not assign a monetary value to time off homemaking, volunteer activities, caregiving or caregiver assistance.

We obtained direct costs associated with the surgical procedure from a previous analysis at our institution,[25] and direct costs of other related procedures (e.g., irrigation and débridement) from the Ontario Case Costing Initiative.[26] Direct costs included those related to implants, equipment, operating room, nursing, pharmacy and medicine, as well as hospital length of stay. Time spent in each hospital department (postanesthesia care unit [PACU], recovery or inpatient ward) postoperatively was recorded during the study, and cost per unit time spent in each area was provided by our institution. We obtained anesthesiologist and surgeon billing fees from the Ontario Ministry of Health Schedule of Benefits.[23] We estimated the total cost for each participant over their 12-week involvement in the study and reported all costs in 2019 Canadian dollars.

Statistical analysis

We analyzed the data using Stata/IC version 16.1 software (StataCorp). We conducted our primary analysis following the intention-to-treat principle. We used descriptive statistics to present the demographic characteristics of the treatment groups, with means and ranges for continuous variables (age, body mass index, height, weight) and proportions for nominal variables (sex, operative hip, smoking status, contralateral THA).

We imputed missing WOMAC data using multiple imputation with chained equations. We used predictive mean matching pulling from 5 nearest neighbours and included 7 iterations, with group (according to intention to treat), smoking status (yes or no), body mass index, previous THA (yes or no), age and sex used as covariates in the multiple imputation with chained equations model.

We compared cost and WOMAC scores (total and each subscale at baseline and 12 wk) between the outpatient and inpatient groups using linear regression, with group as the predictor. For the analysis of 12-week WOMAC scores, we also included baseline scores as a covariate. All comparisons were based on bootstrapped standard errors and 95% confidence intervals (CIs). We

used nonparametric bootstrapping with 5000 replications. We performed cost analyses from both health care payer and societal perspectives. The health care payer perspective included direct costs (visits to health care professionals, procedures, medications, tests, hospital admissions and visits to emergency departments), and the societal perspective included both direct and indirect costs (time off paid employment, volunteer activities and patients' out-of-pocket expenses).

We performed 6 one-way sensitivity analyses:

- Valuing participants' unpaid time off (including time off caregiving, homemaking and volunteer work) at minimum wage in Ontario ($14/h[27])
- Valuing caregiver assistance time at minimum wage in Ontario
- Analyzing participants who crossed over as treated from a health care payer perspective
- Analyzing participants who crossed over as treated from a societal perspective
- With outliers (residuals > 2) removed to assess how these affected our results from a health care payer perspective and
- With outliers (residuals > 2) removed to assess how these affected our results from a societal perspective.

Results

A total of 125 patients were enrolled prospectively, of whom 105 (49 outpatients and 56 inpatients) completed the 12-week follow-up and were included in the analysis (Figure 1). Seven participants allocated to the outpatient group crossed over and stayed overnight in hospital owing to inability to meet the discharge criteria in 2 patients, decreased oxygen levels necessitating overnight monitoring in 2 patients and, in 1 patient each, pain, wound concerns and intraoperative cardiac issues. Five participants allocated to the inpatient group crossed over and went home on the same day as surgery because they met the

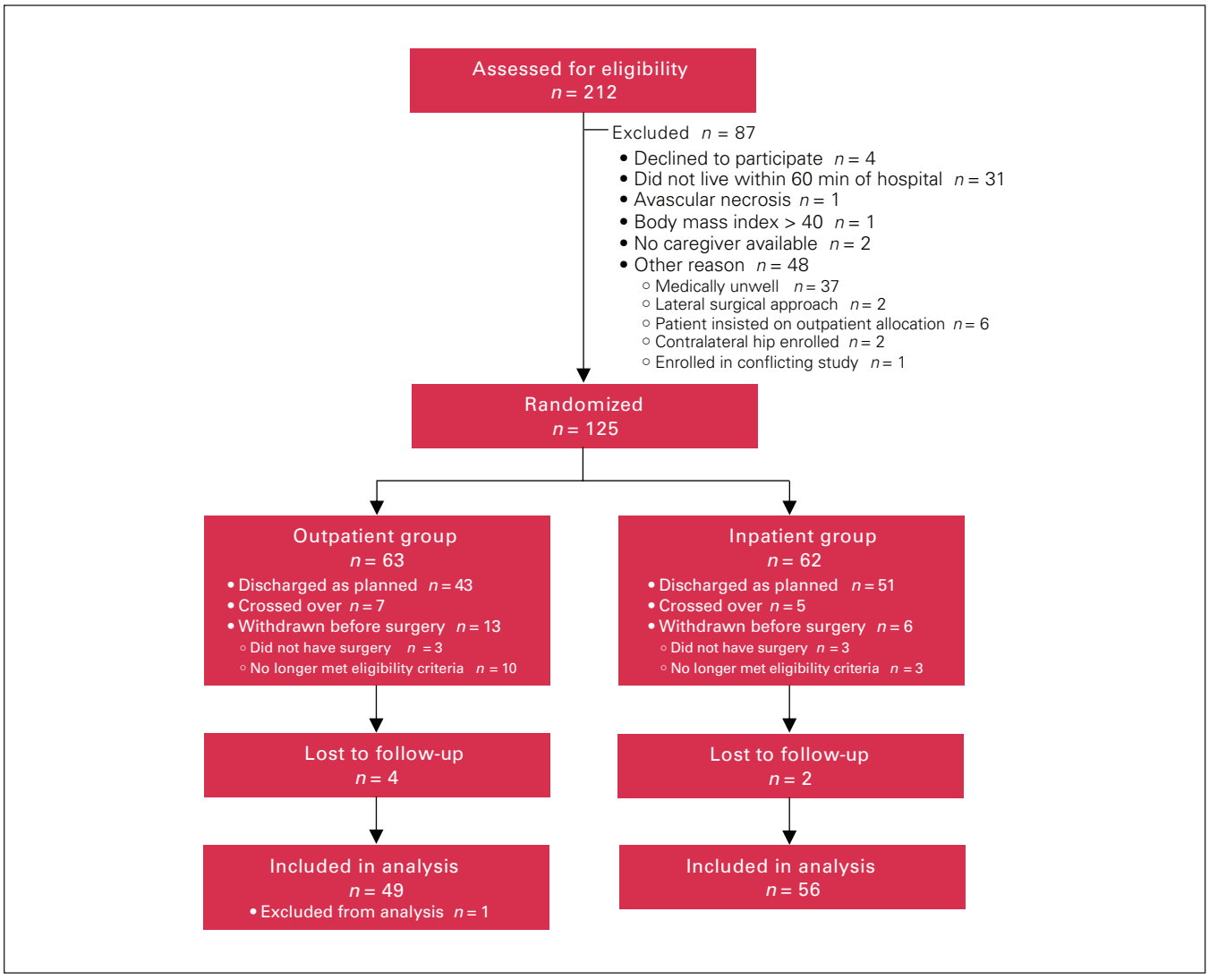

Fig. 1. Flow diagram showing participant selection.

discharge criteria and hospital staff who were unaware of study group allocation sent them home. No participants were unblinded before the debriefing discussion 12 weeks postoperatively, and only 1 participant declined to sign the debriefing consent and therefore had their data excluded from the analysis. All participants were discharged directly to their home or the home of their caregiver (family member or friend).

Demographic and surgical characteristics were similar between groups with the exception of mean change in hemoglobin level (–25.8 g/L in inpatients and –14.5 g/L in outpatients; mean difference –11.2 g/L, 95% CI –14.3 g/L to –8.1 g/L) (Table 1 and Table 2). The mean length of stay in the outpatient group was 20.3 h (95% CI 10.4 h to 30.1 h) less than that of inpatients in our intention-to-treat analysis. When we analyzed the data for participants who crossed over as treated, the average length of stay was 8.8 (range 6.6–12.5) h in the outpatient group and 39.3 (range 24.7–218.6) h in the inpatient group.

Table 1. Demographic characteristics of patients who underwent total hip arthroplasty as an inpatient or outpatient procedure

Characteristic	No. (%) of participants*	
	Inpatients *n* = 56	Outpatients *n* = 49
Height, mean ± SD, in (cm)	67.2 ± 3.4 (170.7 ± 8.6)	67.6 ± 3.8 (171.7 ± 9.6)
Weight, mean ± SD, lb (kg)	175.7 ± 40.0 (79.7 ± 18.1)	172.7 ± 37.9 (78.3 ± 17.2)
Body mass index, mean ± SD	27.2 ± 5.0	26.3 ± 4.1
Age, mean ± SD, yr	63.6 ± 10.5	64.6 ± 9.4
Male sex	27 (48)	27 (55)
Contralateral hip symptoms	18 (32)	13 (26)
Contralateral THA	9 (16)	12 (24)
Smoker	4 (7)	5 (10)
ASA score		
1	7 (12)	7 (14)
2	27 (48)	28 (57)
3	22 (39)	14 (29)
Charlson Comorbidity Index score		
0	41 (73)	40 (82)
1	14 (25)	8 (16)
2	1 (2)	1 (2)

ASA = American Society of Anesthesiologists; SD = standard deviation, THA = total hip arthroplasty.
*Except where noted otherwise.

As expected, time from admission to the PACU was significantly shorter in the outpatient group than in the inpatient group (mean difference 0.8 h, 95% CI 0.5 h to 1.1 h), as was time from recovery or inpatient ward to discharge (mean difference 19.9 h, 95% CI 9.5 h to 30.2 h). Time in the PACU was similar between the groups when analyzed per intention to treat (mean difference 0.3 h, 95% CI –0.4 h to 0.9 h) but was significantly shorter in the outpatient group when analyzed as treated (mean difference 0.8 h, 95% CI 0.2 h to 1.5 h).

There was 1 significant outlier with a length of stay greater than 150 h in both groups. The outlier in the outpatient group remained in hospital for 151.2 h owing to increased oxygen requirements and drowsiness postoperatively, thought to be due to postoperative narcotic use and medication interactions. The outlier in the inpatient group remained in hospital for 218.6 h owing to an intraoperative femoral fracture; the patient was kept non–weight-bearing postoperatively and remained in hospital while awaiting a bed in a transitional care unit.

At 12 weeks, WOMAC total scores and function subscale scores were higher for the outpatient group than for the inpatient group (mean difference 2.3, 95% CI 0.4 to 4.2, and 7.0, 95% CI 0.6 to 13.5, respectively) (Table 3). All other WOMAC scores were similar for the 2 groups.

Adverse events

The rate of adverse events was similar for the 2 groups, with 7 events in 4 participants in the inpatient group and 3 events in 2 participants in the outpatient group ($p = 0.2$) (Table 4). Only 1 adverse event in the outpatient group, analgesia overdose, was possibly related to the timing of discharge. This participant presented to the emergency department by ambulance after experiencing an overdose 2 days after surgery from misunderstanding their analgesia prescription. The overdose resolved uneventfully. Important events in the inpatient group included

Table 2. Surgical and length of stay information

Variable	Mean (range)		
	Inpatients	Outpatients	Mean difference (95% CI)
Change in hemoglobin level, g/L	–25.8 (–6.0 to –47.0)	–14.5 (–1.0 to –30.0)	–11.2 (–14.3 to –8.1)
Operative time, min	69.3 (47.0 to 136.0)	72.4 (36.0 to 191.1)	–3.1 (–10.0 to 3.8)
Length of stay, h	35.1 (8.2 to 218.6)	14.9 (6.6 to 151.2)	20.3 (10.4 to 30.1)
Admission to PACU, h	4.5 (1.3 to 10.0)	3.7 (2.0 to 5.4)	0.8 (0.5 to 1.1)
Time in PACU, h	2.6 (0.0 to 7.5)	2.3 (0.8 to 8.4)	0.3 (–0.4 to 0.9)
Time from PACU to discharge, h	28.0 (2.5 to 214.6)	8.2 (0.0 to 140.9)	19.9 (9.5 to 30.2)

CI = confidence interval; PACU = postanesthesia care unit.

Table 3. Mean Western Ontario and McMaster Universities Osteoarthritis Index total and subscale scores at baseline and 12 weeks postoperatively

Total/subscale; time point	Mean score ± SD		Mean difference (95% CI)
	Inpatients	Outpatients	
Total			
Baseline	83.2 ± 6.2	81.4 ± 4.9	–1.6 (–3.8 to 0.5)
12 wk	94.6 ± 6.1	96.0 ± 3.7	2.1 (0.0 to 4.1)
Pain			
Baseline	52.6 ± 17.9	48.2 ± 17.6	–4.1 (–10.8 to 2.5)
12 wk	86.8 ± 17.0	88.9 ± 13.0	3.9 (–2.0 to 9.9)
Stiffness			
Baseline	46.2 ± 18.3	40.7 ± 17.0	–5.5 (–12.3 to 1.2)
12 wk	77.4 ± 21.6	79.8 ± 17.5	4.5 (–2.8 to 11.8)
Function			
Baseline	52.6 ± 18.4	47.5 ± 14.3	–4.8 (–10.8 to 1.3)
12 wk	84.4 ± 18.5	89.3 ± 9.9	6.5 (0.4 to 12.5)

CI = confidence interval; SD = standard deviation.

Table 4. Frequency of adverse events

Adverse event	No. of events (patients)	
	Inpatients	Outpatients
Major complications		
Dislocation	1	0
Intraoperative fracture	1	0
Deep infection	1	0
Analgesia overdose	0	1
Minor complications		
Superficial infection	1	1
Urinary tract infection	1	0
Fall	1	0
Medical complications		
Atrial flutter	0	1
Atrial fibrillation	1	0
Total	7 (4)	3 (2)

Table 5. Costs reported by participants over the study period

Cost	Cost, mean ± SD, $*	
	Inpatients	Outpatients
Direct costs		
Hospital		
Procedure	6447.36[25]	6447.36[25]
PACU	306.56 ± 192.41	275.96 ± 181.72
Day surgery	35.90 ± 117.87	285.20 ± 169.05
Ward	838.33 ± 857.47	186.12 ± 659.77
Total	7628.15 ± 805.14	7194.64 ± 690.71
Health care provider		
Physician	778.71 ± 404.47	713.33 ± 36.16
Physiotherapy†	346.21 ± 246.28	312.80 ± 166.06
Occupational therapy†	11.79 ± 49.99	15.71 ± 77.78
Anesthesiologist	242.84 ± 37.55	252.98 ± 55.99
Other†‡	2.23 ± 16.70	0
Total†	1381.78 ± 479.71	1294.82 ± 194.43
Medication†	51.94 ± 75.56	71.45 ± 96.85
Tests and radiographs	47.94 ± 5.77	44.99 ± 2.45
Emergency visits and hospital admissions	610.63 ± 3250.04	70.78 ± 157.97
Other out-of-pocket expenses	242.80 ± 34.83	148.98 ± 24.36
Indirect costs		
Time off paid employment	3368.88 ± 5407.51	2792.98 ± 4701.20
Time off volunteer activities§	446.00 ± 1540.19	36.57 ± 225.61
Time off homemaking§	1278.00 ± 1663.76	717.43 ± 1020.86
Time off caregiving§	0	116.57 ± 370.02
Caregiver assistance§	693.65 ± 789.64	619.39 ± 817.14

PACU = postanesthesia care unit; SD = standard deviation.
*2019 Canadian dollars.
†Given the Canadian health care system, some medical costs were covered partially by the health care payer or private insurance, or were paid out of pocket by the patient. Therefore, only some of the medication costs or physiotherapy costs, for example, would be included in the health care payer perspective.
‡Includes home care nurses, chiropractors, osteopaths and massage therapists.
§Valued at $14/hour.

dislocation in 1 patient, which occurred 6 weeks after surgery, and deep infection in 1 patient, treated with irrigation and débridement, with head and liner exchange, 3 weeks after surgery. Both events had resolved uneventfully by 12 weeks postoperatively.

Costs

Costs reported by participants over the course of the study are summarized in Table 5. Costs were less in the outpatient group than in the inpatient group from both health care payer and societal perspectives for the base-case analysis as well as all sensitivity analyses (Table 6).

Discussion

This study showed outpatient THA to be significantly less expensive than inpatient THA from both a health care payer and a societal perspective.

Our results are similar to those of other cost analyses reported in the literature. A 2015 systematic review by Crawford and colleagues[4] showed cost savings of 17.6%–57.6% for outpatient relative to inpatient hip and knee arthroplasty. We found cost savings of 6% and 10% from a health care payer perspective and a societal perspective, respectively. Studies of costs in the US showed overall higher associated costs for outpatient THA and greater differences in costs between outpatient and inpatient procedures. Bertin[2] reported mean savings of more than US$4000 for outpatient THA, and Aynardi and colleagues[3] found mean savings of almost US$7000 for direct anterior THA performed at an outpatient centre compared to an inpatient hospital.

Our study showed savings of about $1000 from a health care payer perspective, lower than savings reported in the US. However, this is to be expected, given the overall lower associated costs in Canada and shorter hospital stays for both outpatients and inpatients (for example, 14.9 h in the present study v. 24.6 h in the study by Aynardi and

Table 6. Mean costs from health care payer and societal perspectives in base-case and sensitivity analyses over the study period

Scenario	Cost, mean ± SD, $		Mean difference (95% CI)
	Inpatients	Outpatients	
Health care payer perspective			
Base case	9608.64 ± 3962.41	8601.78 ± 741.47	–1006.86 (–2158.92 to 145.21)
As treated	9732.00 ± 3899.01	8402.47 ± 286.85	–1329.53 (–2473.39 to –185.67)
Outliers removed	8859.70 ± 417.73	8601.78 ± 741.47	–257.92 (–491.04 to –24.79)
Societal perspective			
Base case	13 346.29 ± 6264.76	11 678.89 ± 4733.29	–1667.40 (–3856.64 to 521.84)
As treated	12 923.15 ± 5839.80	12 139.92 ± 5423.85	–783.23 (–2999.77 to 1433.32)
Outliers removed	11 992.14 ± 3921.78	11 678.89 ± 4733.29	–313.25 (–2033.18 to 1406.67)
Unpaid time off included	15 070.29 ± 7165.14	12 564.10 ± 5071.30	–2506.19 (–4959.29 to –53.09)
Caregiver assistance included	15 763.93 ± 7182.08	13 185.14 ± 5310.05	–2578.80 (–5071.08 to –86.51)

CI = confidence interval; SD = standard deviation.
*2019 Canadian dollars.

colleagues[3] for outpatients, and 35.1 h v. 73.8 h, respectively, for inpatients). When we investigated cost savings from a societal perspective, we incorporated indirect costs for both patients and their caregivers, as an increasing number of patients are undergoing THA at a younger age and are thus still in the workforce, and an important component of the outpatient pathway involves caregiver support in the immediate postoperative period. This resulted in cost savings of about $2600 for outpatient THA when all indirect costs were included.

There was uncertainty in our estimate of cost for the base-case analysis, as shown by the wide 95% CIs spanning values over a range of almost $2300 for the health care payer perspective and about $4000 for the societal perspective, both of which included positive values. For the health care payer perspective, the removal of the 2 outliers reduced our uncertainty greatly, decreasing the range of the 95% CI to about $500 and no longer including a positive difference. When we investigated these outliers further, we found that both patients had experienced adverse events that resulted in further treatment. The inclusion of these 2 participants in our base-case analysis greatly increased the uncertainty in our estimate, as their costs were more than double the next largest reported cost over the study period, and both were in the inpatient group.

The minimum clinically important difference (MCID) in WOMAC scores for patients undergoing THA is at least 25 points for each subscale.[28] Goldsmith and colleagues[29] proposed that the between-group MCID is about 20%–40% of the within-group MCID, which would make a difference of at least 5 points applicable for the WOMAC subscales. According to this standard, the difference we found between the groups in the WOMAC function subscale, 7.0 points, is clinically important; however, the lower bound of the 95% CI also includes nonclinically important differences of less than 5. The difference we found between groups for the total WOMAC score falls below the threshold of 5, as do both the upper and lower bounds of the 95% CI; therefore, we cannot say that the difference we found is clinically important to patients.

Our finding that outpatients spent significantly less time in hospital between admission and surgery than inpatients may be explained by the timing of surgery: 83.7% of participants in the outpatient group had surgery before 0900, compared to only 19.6% of participants in the inpatient group. Since patients at our institution are requested to arrive 3 hours before surgery for all procedures occurring after 0900, but only 2 hours in advance of earlier procedures, this may explain the observed difference.

Our overall adverse event rate, 9.5%, is at the high end of the range of serious adverse event rates reported in the literature, 3.8%–8.6%.[30–33]

Limitations

A strength of this study is the blinding we were able to implement in our study design. The Zelen model[21] allowed us to keep participants blinded to the randomization process so that they were not aware of the presence of another study group. We believe this helped us to limit our rate of crossover compared to what Goyal and colleagues[20] experienced in their study. Their crossover rate was fairly high, as their participants were aware of the other group and had the option to switch if they preferred. Blinding is difficult in a study that looks to examine timing of discharge and is not possible with most traditional study designs. Although we also experienced crossover in the inpatient group, our rate was 11%, compared to 25% in Goyal and colleagues' study.[20]

This study is a preliminary analysis of the first group of patients to complete follow-up in a larger randomized trial. As such, a limitation of this study is the relatively small sample. A larger sample is required to have sufficient power to determine the safety of outpatient THA, with longer-term follow-up to conduct a full economic

evaluation to estimate the cost-effectiveness of outpatient THA. A larger sample will also help to reduce the uncertainty in our estimates and provide more precision in our results, particularly costs.

Another limitation is that all operations were performed by a single surgeon with a single surgical approach, direct anterior. As such, it is possible that the results of this study are not generalizable to the THA population as a whole. As more surgeons have since joined the randomized trial, results from the full study, once available, should have greater external validity.

There is also the possibility of recall bias, as many of the costs we assessed were established via patient-reported questionnaires. However, as participants were asked to complete the questionnaires at multiple time points throughout the study, including daily for the first 2 weeks after surgery, the effects should be minimal. The longest period over which participants were asked to recall costs was 6 weeks (they were asked for costs over the preceding 6 wk at the final study visit). The risk of recall bias would be more pronounced if participants had been asked to recall costs over longer periods. In addition, as both groups of participants were asked to complete the questionnaires at the same time points, there should be no systematic differences between the groups.

Conclusion

We found outpatient THA to be less costly than inpatient THA from both a health care payer and a societal perspective. We found higher total and function subscale WOMAC scores 12 weeks after surgery for the outpatient group than the inpatient group, although the 95% CIs around the estimates were large. Adverse event rates were similar for the 2 groups. Further study with larger samples is needed to provide more precision around our estimates.

Acknowledgement: The authors acknowledge Michael Pollock for his work in participant recruitment and data collection.

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Funding: This work was supported by the Opportunities Fund of the Academic Health Sciences Centre Alternative Funding Plan of the Academic Medical Organization of Southwestern Ontario. Funding was also received from the Physicians' Services Incorporated Foundation (grant 17-21). Neither funding source played a role in how the study was conducted.

Competing interests: Brent Lanting reports a principal investigator grant, institutional support and consulting fees from Smith & Nephew, Stryker and DePuy Synthes. He is chair of the Canadian RSA Network. No other competing interests were declared.

Contributors: D. Bryant and J. Marsh designed the study. B. Zomar acquired the data, which B. Zomar and B. Lanting analyzed. B. Zomar wrote the manuscript, which D. Bryant, J. Marsh and B. Lanting critically revised. All authors gave final approval of the article to be published.

References

1. Hip and knee replacements in Canada, 2016–2017: Canadian Joint Replacement Registry annual report. Ottawa: Canadian Institute for Health Information; 2018.
2. Bertin KC. Minimally invasive outpatient total hip arthroplasty: a financial analysis. *Clin Orthop Relat Res* 2005;435:154-63.
3. Aynardi M, Post Z, Ong A, et al. Outpatient surgery as a means of cost reduction in total hip arthroplasty: a case–control study. *HSS J* 2014;10:252-5.
4. Crawford DC, Li CS, Sprague S, et al. Clinical and cost implications of inpatient versus outpatient orthopedic surgeries: a systematic review of the published literature. *Orthop Rev (Pavia)* 2015;7:6177.
5. Gromov K, Jørgensen GC, Petersen PB, et al. Complications and readmissions following outpatient total hip and knee arthroplasty: a prospective 2-center study with matched controls. *Acta Orthop* 2019;90:281-5.
6. Hoffmann JD, Kusnezov NA, Dunn JC, et al. The shift to same-day outpatient joint arthroplasty: a systematic review. *J Arthroplasty* 2018;33:1265-74.
7. Pollock M, Somerville L, Firth A, et al. Outpatient total hip arthroplasty, total knee arthroplasty, and unicompartmental knee arthroplasty: a systematic review of the literature. *JBJS Rev* 2016;4:1-15.
8. Richards M, Alyousif H, Kim JK, et al. An evaluation of the safety and effectiveness of total hip arthroplasty as an outpatient procedure: a matched-cohort analysis. *J Arthroplasty* 2018;33:3206-10.
9. Arshi A, Leong NL, Wang C, et al. Outpatient total hip arthroplasty in the United States: a population-based comparative analysis of complication rates. *J Am Acad Orthop Surg* 2019;27:61-7.
10. Basques BA, Tetreault MW, Della Valle CJ. Same-day discharge compared with inpatient hospitalization following hip and knee arthroplasty. *J Bone Joint Surg Am* 2017;99:1969-77.
11. Courtney PM, Boniello AJ, Berger RA. Complications following outpatient total joint arthroplasty: an analysis of a national database. *J Arthroplasty* 2017;32:1426-30.
12. Lovecchio F, Alvi H, Sahota S, et al. Is outpatient arthroplasty as safe as fast-track inpatient arthroplasty? A propensity score matched analysis. *J Arthroplasty* 2016;31(Suppl 9):197-201.
13. Nelson SJ, Webb ML, Lukasiewicz AM, et al. Is outpatient total hip arthroplasty safe? *J Arthroplasty* 2017;32:1439-42.
14. Otero JE, Gholson JJ, Pugely AJ, et al. Length of hospitalization after joint arthroplasty: Does early discharge affect complications and readmission rates? *J Arthroplasty* 2016;31:2714-25.
15. Kort NP, Bemelmans YFL, van der Kuy PHM, et al. Patient selection criteria for outpatient joint arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2017;25:2668-75.
16. Berger RA, Sanders SA, Thill ES, et al. Newer anesthesia and rehabilitation protocols enable outpatient hip replacement in selected patients. *Clin Orthop Relat Res* 2009;467:1424-30.
17. Chen D, Berger RA. Outpatient minimally invasive total hip arthroplasty via a modified Watson-Jones approach: technique and results. *Instr Course Lect* 2013;62:229-36.
18. Dorr LD, Thomas DJ, Zhu J, et al. Outpatient total hip arthroplasty. *J Arthroplasty* 2010;25:501-6.
19. Hartog YM, Mathijssen NM, Vehmeijer SB. Total hip arthroplasty in an outpatient setting in 27 selected patients. *Acta Orthop* 2015;86:667-70.

20. Goyal N, Chen AF, Padgett SE, et al. Otto Aufranc Award: a multicenter, randomized study of outpatient versus inpatient total hip arthroplasty. *Clin Orthop Relat Res* 2017;475:364-72.
21. Zelen M. A new design for randomized clinical trials. *N Engl J Med* 1979;300:1242-5.
22. McConnell S, Kolopack P, Davis M. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): a review of its utility and measurement properties. *Arthritis Rheum* 2001;45: 453-61.
23. Schedule of benefits: physician services under the Health Insurance Act. Toronto: Ontario Ministry of Health; 2015.
24. Ontario Drug Benefit Formulary/Comparative Drug Index: No. 41, updates J, K and L. Toronto: Ministry of Health and Long-Term Care; 2009.
25. Petis SM, Howard JL, Lanting BA, et al. In-hospital cost analysis of total hip arthroplasty: Does surgical approach matter? *J Arthroplasty* 2016;31:53-8.
26. Version 7.1 Acute inpatient databases for fiscal year 2010/11. Toronto: Ontario Case Costing Initiative; 2011.
27. Minimum wage. Toronto: Government of Ontario. Available: https://www.ontario.ca/document/your-guide-employment-standards-act-0/minimum-wage (accessed 2019 July 11).
28. Quintana JM, Escobar A, Bilbao A, et al. Responsiveness and clinically important differences for the WOMAC and SF-36 after hip joint replacement. *Osteoarthritis Cartilage* 2005;13:1076-83.
29. Goldsmith CH, Boers M, Bombardier C, et al. Criteria for clinically important changes in outcomes: development, scoring and evaluation of rheumatoid arthritis patient and trial profiles. OMERACT Committee. *J Rheumatol* 1993;20:561-5.
30. Ponnusamy KE, Naseer Z, El Dafrawy MH, et al. Post-discharge care duration, charges and outcomes among Medicare patients after primary total hip and knee arthroplasty. *J Bone Joint Surg Am* 2017; 99:e55.
31. Bernatz JT, Tueting JL, Anderson PA. Thirty-day readmission rates in orthopedics: a systematic review and meta-analysis. *PLoS One* 2015;10:e0123593.
32. Soohoo NF, Farng E, Lieberman JR, et al. Factors that predict short-term complication rates after total hip arthroplasty. *Clin Orthop Relat Res* 2010;468:2363-71.
33. Varacallo MA, Herzog L, Toossi N, et al. Ten-year trends and independent risk factors for unplanned readmission following elective total joint arthroplasty at a large urban academic hospital. *J Arthroplasty* 2017;32:1739-46.