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# Significant cost savings and similar patient outcomes associated with early discharge following total knee arthroplasty

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**Background:** A substantial portion of the cost of total knee arthroplasty (TKA) results from the postoperative inpatient length of stay (LOS). Considering the annual increase in TKAs, reducing LOS represents a potential for cost savings. We sought to compare in-hospital costs and patient-reported outcomes for an early discharge protocol compared with the standard LOS following TKA.

**Methods:** We conducted a retrospective matched cohort study, matching patients on age, sex, body mass index and preoperative Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC) score. We compared costs associated with time in the operating room, intraoperative pain control and inpatient stay as well as 1-year postoperative patient-reported outcomes between early discharge and standard LOS groups.

**Results:** We included 50 patients in our study (25 per group). The average LOS in the early discharge group was 26.5 hours, compared with 48.9 hours in the standard care group. The early discharge group had higher intraoperative costs associated with pain control (mean difference 26.98, 95% confidence interval 14.41–37.90,  $p < 0.01$ ); however, this difference was offset by substantial savings associated with the reduced LOS. The mean total cost for the early discharge group was \$649.62 ± \$281.71 versus \$1279.71 ± \$515.98 for the standard care group. There were no significant differences in SF12 or WOMAC scores between groups at 1 year postoperative.

**Conclusion:** In-hospital costs were significantly lower with a postoperative day 1 discharge protocol than with standard LOS following TKA, with no difference in patient-reported outcomes.

**Contexte :** Une portion substantielle du coût de l'arthroplastie pour prothèse totale du genou (PTG) est liée à la durée du séjour postopératoire. Compte tenu de l'augmentation annuelle des cas de PTG, abréger les séjours représente une source potentielle d'économies. Nous avons comparé les coûts hospitaliers et les résultats signalés par les patients avec un protocole de congé rapide et avec le séjour de durée standard après la PTG.

**Méthodes :** Nous avons procédé à une étude de cohorte rétrospective appariée, où les patients étaient assortis selon le l'âge, le sexe, l'indice de masse corporelle et le score WOMAC (Western Ontario & McMaster Universities Osteoarthritis) préopératoire. Nous avons comparé les coûts associés au temps passé au bloc opératoire, au contrôle de la douleur peropératoire et au séjour hospitalier, de même que les résultats signalés par les patients 1 an après l'intervention entre les 2 groupes (congé rapide c. durée de séjour standard).

**Résultats :** Nous avons inclus 50 patients dans notre étude (25 par groupe). Le séjour moyen du groupe soumis au congé rapide a été de 26,5 heures, contre 48,9 heures pour le séjour standard. Le groupe soumis au congé rapide a présenté des coûts peropératoires plus élevés associés au contrôle de la douleur (différence moyenne 26,98, intervalle de confiance de 95 % 14,41–37,90,  $p < 0,01$ ); par contre, cette différence a été compensée par d'importantes économies associées à des séjours plus courts. Le coût total moyen pour le groupe soumis au congé rapide a été de 649,62 \$ ± 281,71 \$ contre 1279,71 \$ ± 515,98 \$ pour le séjour standard. On n'a noté aucune différence significative pour ce qui est des scores SF12 ou WOMAC entre les groupes 1 an après l'intervention.

**Conclusion :** Les coûts perhospitaliers ont été significativement moindres avec le protocole de congé postopératoire rapide (après 1 jour), comparativement au séjour standard après la PTG, sans différence en ce qui concerne les résultats signalés par les patients.

Total knee arthroplasty (TKA) is an established, effective intervention for advanced osteoarthritis (OA) of the knee. The prevalence of knee OA is rapidly increasing, resulting in a rising demand for care and contributing to substantial strains on the health care system.<sup>1</sup> The number of TKA procedures is expected to grow by 48% by 2020.<sup>2</sup> The procedure has a substantial economic impact, costing approximately \$500 million annually in Ontario alone.<sup>3</sup> These numbers highlight the critical need to identify more efficient methods of care delivery while maintaining safety and patient outcomes.

Historically, standard practice following TKA involved an inpatient hospital stay of 2.5–3 weeks; however, the introduction of less invasive surgical techniques, improved management and comprehensive rehabilitation have enabled shorter inpatient stays. Today, the average inpatient stay following surgery is 2–4 days.<sup>4</sup>

A substantial portion of the overall cost of TKA results from the inpatient hospital length of stay (LOS) following the procedure. Considering the large and increasing number of these procedures performed annually, further reducing the LOS through an accelerated discharge model of care represents a potential for significant cost savings. Although decreasing LOS is a novel opportunity to improve economic efficiency, high-quality, evidence-based comparisons to traditional inpatient models of both costs and patient outcomes are lacking. Furthermore, accelerated discharge protocols involve substantial changes to current practice, therefore an evaluation of potential barriers to adopting an early discharge program is warranted.

The objective of this study was to compare in-hospital costs and patient-reported outcomes associated with an early discharge protocol compared with the standard LOS following TKA. Our secondary objective was to demonstrate some of the challenges associated with adopting an early discharge program and discuss potential solutions.

## METHODS

We conducted a retrospective matched comparative cohort study. We compared an early discharge patient care pathway group to a group of patients who had the standard LOS following TKA. Patients were matched on age, sex, body mass index (BMI) and preoperative Western Ontario and McMaster University Osteoarthritis Index (WOMAC) score. We obtained approval from our institution's research ethics board to conduct this study.

### *Interventions*

Patients in the early discharge group received an accelerated discharge protocol. Prior to surgery, patients were informed of the anesthesia protocols as well as expectations around the enhanced discharge program. The patient and caregiver were informed of the projected care pathway

details. Potential complications were also discussed so that the patient understood the normal course of recovery as well as signs or symptoms that would be cause for concern and require additional consultation. The patients received a spinal anesthetic as well as a periarticular multimodal injection. Sedation used intraoperatively was left to the discretion of the anesthesiologist. Patients also received a nerve block for pain and were sent home with a pain pump connected to the intra-articular catheters with continuous ropivacaine infusion. These catheters were removed at 72 hours by the patient.

Patients in the usual care group did not receive any additional analgesics and were discharged according to current, standard protocols for TKA. At our institution the standard of care LOS is 2–3 days following the procedure; our standard is shorter than the provincial guideline of 4 days.

Discharge criteria were similar in both groups: demonstrated ability to use the required gait aids, appropriate pain control, control or absence of nausea and vomiting, hemostasis at the surgical wound, hemodynamic stability with appropriate laboratory values, alertness and orientation, ability to use the bathroom, standard targets from physiotherapy for discharge, take-home medications and availability of a caregiver.

### *Eligibility criteria*

Patients were eligible for the early discharge protocol if they were undergoing primary TKA for knee OA, had an American Society of Anesthesiologists (ASA) score  $\leq 3$ , and were able to read and understand English. They were also required to live within a 60-minute drive of the hospital, have access to a phone, and have sufficient caregiver support at home. We excluded patients with a history of anesthesia-related complications, narcotic dependency, reliance on a walker and/or wheelchair for mobility, anaphylaxis to penicillin, psychosocial issues that may influence safety, or cognitive issues that precluded the ability to understand instructions. Consenting patients who met the eligibility criteria were included in the study; however, these patients were not a sequential cohort based on patient eligibility and resource needs. Both the anesthesiologist and surgeon discussed whether the patient was an appropriate candidate for early discharge before enrolling them in that group.

### *In-hospital resource use*

We recorded all costs associated with each procedure during the in-hospital stay, including length of time in the operating room, anesthesia-related costs, intraoperative pain medication, LOS (including both time in postanesthesia recovery unit and on the inpatient floor until discharge), as well as physiotherapy consultations, medication use and

any other inpatient resource use (including those associated with complications) up until discharge. We did not include procedure-related equipment and implant costs, as these were assumed to be identical between groups. We obtained unit costs for each item of resource use from the case costing department at our institution. All costs are reported in 2017 Canadian dollars.

**Patient-reported outcomes**

All patients prospectively completed the SF-12 and the WOMAC questionnaires preoperatively and 1 year postoperatively.

**Statistical analysis**

We used descriptive statistics to summarize baseline characteristics of the study participants. We compared costs associated with time in the operating room, intraoperative pain control, inpatient stay and the total overall cost between groups. We compared costs and 1-year quality of life outcomes between groups using an independent sample *t* test. If the data did not meet the assumptions of a *t* test, we conducted nonparametric bootstrapping to compare the mean differences between groups.

**RESULTS**

There were 25 patients who underwent primary TKA with the early discharge protocol at our institution between 2015–2016. They were matched to 25 patients who underwent a primary TKA during the same time period and received the standard of care treatment and LOS. Patients were similar in baseline characteristics and preoperative WOMAC scores (Table 1).

The average LOS in the early discharge group was 26.5 hours, compared with 48.9 hours in the usual care group. Seven patients in the early discharge group experienced a delayed discharge resulting in an LOS longer than 24 hours (catheter leakage *n* = 4, pain control *n* = 1, vasovagal *n* = 1, urinary retention *n* = 1).

The early discharge group had higher intraoperative costs associated with pain control (mean difference 26.98, 95% confidence interval [CI] 14.41 to 37.90, *p* < 0.01);

however, these differences were offset by significant savings from the reduced LOS. The mean total cost for the early discharge group was \$649.62 ± \$281.71 versus \$1279.71 ± \$515.98 for the standard care group (mean difference -934.44, 95% CI -1453.16 to -483.54, *p* < 0.01; Table 2).

Patients in both groups reported similar quality of life and function following surgery. There were no significant differences in the SF12 mental and physical component scores or WOMAC total score between the 2 groups 1 year postoperatively (Table 3).

**DISCUSSION**

We found significantly lower in-hospital costs with a postoperative day 1 discharge protocol than with the standard LOS following TKA, with no difference in patient-reported outcomes 1 year following surgery. At our institution, the standard of care LOS is an average of 2–3 days, which is even lower than the suggested provincial guideline of 4 days,<sup>4</sup> therefore even greater cost savings may be realized with an early discharge protocol at other institutions.

Previous studies have evaluated the impact of reduced LOS on clinical outcomes and found that an earlier discharge is a feasible alternative to traditional inpatient TKA. For example, Raphael and colleagues<sup>5</sup> evaluated a reduced LOS protocol (average length of stay of 47 h v. 116 h) and found no increase in complication or readmission rates.

**Table 1. Demographic and clinical characteristics of the study sample**

Characteristic	Group; mean ± SD*		<i>p</i> value
	Early discharge	Standard care	
Age, yr	63.5 ± 4.1	65.4 ± 4.4	0.10
Male sex; no. (%)	13 (50)	13 (50)	—
BMI	29.7 ± 4.3	30.7 ± 4.5	0.41
SF12 MCS	58.3 ± 6.2	59.4 ± 7.6	0.59
SF12 PCS	32.3 ± 6.2	31.6 ± 8.5	0.75
WOMAC total score	51.6 ± 15.6	51.3 ± 14.7	0.94

BMI = body mass index; MCS = mental component score; PCS = physical component score; SD = standard deviation; WOMAC = Western Ontario & McMaster Universities Osteoarthritis Index.  
\*Unless indicated otherwise.

**Table 2. In-hospital costs**

Cost	Group; mean ± SD		Mean difference (95% CI)	<i>p</i> value
	Early discharge	Standard care		
Operating room	1438.85 ± 275.62	1622.77 ± 484.51	-183.91 (-395.17 to 53.31)	0.09
Intraoperative medications	104.36 ± 13.09	77.38 ± 21.76	26.98 (14.41 to 37.90)	< 0.001
Inpatient stay	649.62 ± 281.71	1279.71 ± 515.98	-630.09 (-864.47 to -413.44)	< 0.001
Total cost*	2563.48 ± 396.48	3497.92 ± 916.27	-934.44 (-1453.16 to -483.54)	< 0.001

CI = confidence interval; SD = standard deviation.  
\*The total cost does not include procedure-related equipment and implant costs, as these were assumed to be similar between groups.

**Table 3. Patient-reported outcomes 1 year postoperative**

Outcome measure	Group; mean $\pm$ SD		Mean difference (95% CI)	<i>p</i> value
	Early discharge	Standard care		
SF12 MCS	61.4 $\pm$ 9.5	58.4 $\pm$ 9.9	2.7 (–2.3 to 7.8)	0.27
SF12 PCS	47.4 $\pm$ 11.4	49.5 $\pm$ 11.8	–1.8 (–8.3 to 4.7)	0.56
WOMAC Total	81.3 $\pm$ 13.5	80.4 $\pm$ 23.3	0.92 (–10.3 to 14.7)	0.88

CI = confidence interval; MCS = mental component score; PCS = physical component score; SD = standard deviation; WOMAC = Western Ontario & McMaster Universities Osteoarthritis Index.

Similarly, Kolisek and colleagues<sup>6</sup> compared patients who underwent TKA with an accelerated pathway (discharged within 23 h of surgery) to those who followed a standard inpatient protocol with a mean hospital stay of 2–4 days. They found no differences in perioperative complications, returns to hospital or Knee Society scores at a mean follow up of 24 months. Finally, a retrospective analysis of more than 50 000 total hip arthroplasties (THA) and TKAs found no differences in 30-day major complications or readmissions among patients with a 0–2 day hospital stay compared with those discharged on postoperative day 3 or 4.<sup>7</sup> Although these findings are encouraging, the validity and generalizability of the results are limited by the retrospective nature of the studies and the carefully selected patient cohorts. Furthermore, these studies did not evaluate the economic impact of those results.

Considering the large and increasing number of TKAs performed annually, there is a need to evaluate the economic efficiency of current models of care. This has led some clinicians to perform arthroplasty as an outpatient procedure, where eligible patients are discharged home the same day as their surgery. Eliminating the overnight hospital stay is a novel opportunity to improve economic efficiency, yet large, high-quality, evidenced-based comparisons to traditional inpatient models are lacking.

A retrospective study by Lovald and colleagues<sup>8</sup> estimated that outpatient TKA compared with an inpatient stay of 3–4 days resulted in cost savings of \$8527. Huang and colleagues<sup>9</sup> conducted a case–control study comparing the costs among 20 patients who were discharged the same day of surgery to 20 inpatients who underwent TKA. They found that the same-day discharge resulted in a median cost savings of approximately 30%. At 1 year postoperative, there were no major complications and no returns to hospital or readmissions for either group.<sup>9</sup>

Although these results are encouraging, future study is warranted to determine if similar results can be found in a randomized controlled trial adequately powered to detect differences in adverse event rates between groups, incorporating a full economic evaluation. Importantly, evaluation of barriers to implementation of outpatient pathways is necessary, as an abrupt change in practice to current TKA care pathways may be hindered by changes

to both clinical practice and current funding models. For example, in Ontario, although physicians are reimbursed the same amount for outpatient and inpatient procedures, outpatient TKA is not incorporated into current Quality-Based Procedures (QBP) indicators, therefore hospitals are not compensated for outpatient arthroplasty unless covered under another global funding budget other than the QBP.<sup>3</sup> Furthermore, postoperative physical therapy is covered by public funding only following an overnight stay in hospital.<sup>10</sup> As part of the transition of care, first moving to a postoperative day 1 discharge may enable a smoother, more appropriate transition to outpatient care, allowing sufficient evidence to be generated to inform future funding models and care pathways.

The transition to implementing outpatient THA has followed a similar pathway. Prior studies have reported patient-reported, clinical and cost outcomes following outpatient THA as well as an evaluation of barriers encountered with the accelerated discharge protocols.<sup>11,12</sup> Similarly, the transition of care to reduced LOS in TKA requires changes in practice among all health care providers involved in the care of the patient. This includes changes in surgical approach, such as greater care of soft tissue management, decreased blood loss and reduced tourniquet time. It also may require new anesthesia techniques.

Although our initial intention of the early discharge protocol in the present study was to enable an LOS shorter than 24 hours, the average LOS of patients in the early discharge group was longer than 24 hours. The most common reason for a delay in discharge was complications of the intra-articular catheters used to deliver analgesics. The mode of failure was leakage, demonstrating that newer anesthesia techniques allow pain control issues to be addressed, but may introduce additional complications that affect time to discharge. Our experience highlights several aspects to consider and address when implementing and evaluating an early discharge protocol: the learning curve associated with the changes in the care pathway, effective communication strategies among the entire care team, patient satisfaction with postoperative pain control, and evaluation of the patient and caregiver experience with the new care pathway.

### Limitations

Strengths of this study include a prospective cohort of patients undergoing the postoperative day 1 discharge protocol, with detailed patient-level costing of in-hospital and procedure-related resource use. Although our results may be limited by the small sample size and retrospective comparison group, we matched groups on several characteristics known to influence LOS and outcomes to

minimize the risk of bias. Our preliminary evaluation of the feasibility, costs and clinical outcomes associated with early discharge will enable us to further refine the early discharge protocol, ensuring a smooth transition to outpatient care, and evaluate the cost-effectiveness of outpatient TKA.

## CONCLUSION

Our results suggest that discharge on postoperative day 1 following TKA is a feasible, cost-saving alternative, with no change in patient outcomes. Potential challenges to a successful early discharge must be considered and addressed before implementation as our health care system progresses toward shorter LOS. Future study should investigate adverse events in the immediate postoperative period and any associated costs as well as additional health care resource use, both direct and indirect, over the entire first year after surgery through a full economic evaluation.

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**Competing interests:** None declared.

**Contributors:** J. Howard and B. Lanting designed the study. J. Marsh, L. Somerville and B. Lanting acquired the data, which J. Marsh and B. Lanting analyzed. J. Marsh, L. Somerville and B. Lanting wrote the article, which all authors reviewed and approved for publication.

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