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.
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. The number of TKA procedures is expected to grow by 48% by 2020. The procedure has a substantial economic impact, costing approximately $500 million annually in Ontario alone. 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.

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 ≤ 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,

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 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**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group; mean ± SD*</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>63.5 ± 4.1</td>
<td>65.4 ± 4.4</td>
</tr>
<tr>
<td>Male sex; no. (%)</td>
<td>13 (50)</td>
<td>13 (50)</td>
</tr>
<tr>
<td>BMI</td>
<td>29.7 ± 4.3</td>
<td>30.7 ± 4.5</td>
</tr>
<tr>
<td>SF12 MCS</td>
<td>58.3 ± 6.2</td>
<td>59.4 ± 7.6</td>
</tr>
<tr>
<td>SF12 PCS</td>
<td>32.3 ± 6.2</td>
<td>31.6 ± 8.5</td>
</tr>
<tr>
<td>WOMAC total score</td>
<td>51.6 ± 15.6</td>
<td>51.3 ± 14.7</td>
</tr>
</tbody>
</table>

*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**

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

*The total cost does not include procedure related equipment and implant costs, as these were assumed to be similar between groups.

CI = confidence interval; SD = standard deviation.
Similarly, Kolisek and colleagues\(^6\) 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 than 50 000 total hip arthroplasties (THA) and TKAs

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

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Group, mean ± SD</th>
<th>Mean difference (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF12 MCS</td>
<td>Early discharge</td>
<td>61.4 ± 9.5</td>
<td>2.7 (–2.3 to 7.8)</td>
</tr>
<tr>
<td></td>
<td>Standard care</td>
<td>58.4 ± 9.9</td>
<td></td>
</tr>
<tr>
<td>SF12 PCS</td>
<td>Early discharge</td>
<td>47.4 ± 11.4</td>
<td>–1.8 (–8.3 to 4.7)</td>
</tr>
<tr>
<td></td>
<td>Standard care</td>
<td>49.5 ± 11.8</td>
<td></td>
</tr>
<tr>
<td>WOMAC Total</td>
<td>Early discharge</td>
<td>81.3 ± 13.5</td>
<td>0.92 (–10.3 to 14.7)</td>
</tr>
<tr>
<td></td>
<td>Standard care</td>
<td>80.4 ± 23.3</td>
<td></td>
</tr>
</tbody>
</table>

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

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.\(^1,12\) 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.

**References**