Short stay total joint arthroplasty program: patient factors predicting readmission

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Background: The aim of this study was to evaluate the effectiveness of our short stay arthroplasty program as measured by 30-day readmission rate and the rate of transfer to inpatient care. Risk factors for readmission/transfer were also evaluated and contrasted with current patient screening criteria.

Methods: We retrospectively reviewed 297 charts for all primary total joint arthroplasties completed in the short stay program during an 18-month period. Data included readmission and patient characteristics such as age, sex, comorbidities, the American Society of Anesthesiologists (ASA) physical classification grade, body mass index (BMI) and the number of preoperative medications.

Results: The 30-day readmission rate was 2.6% (n = 8). With the inclusion of patients transferred to the inpatient hospital, the overall failure rate of our short stay program was 6.7% (n = 20). Multivariable modelling controlling for age, BMI and ASA suggested that those with an in-hospital complication were 11.4 times more likely to be readmitted or transferred to inpatient care (p < 0.001) with a trend for patients who were taking more medications (p = 0.09).

Conclusion: The current readmission rate from this program is comparable to previously published data in the arthroplasty literature. However, several patients required transfer to inpatient care, which significantly impacted the effectiveness of the short stay program. Risk factors for readmission/transfer are not completely accounted for by current presurgical screening criteria. Further evaluation of the Blaylock Risk Assessment Screening Score is required to determine its value for predicting hospital readmission.

Contexte : Cette étude avait pour but d'évaluer l'efficacité de notre programme d'arthroplastie court séjour sur la base du taux de réadmission à 30 jours et du taux de conversion en hospitalisation. Les facteurs de risque de réadmission/conversion ont aussi été évalués et mis en parallèle avec les critères actuels de sélection des patients.

Méthodes : Nous avons passé en revue de manière rétrospective les 297 dossiers d'arthroplasties totales primaires effectuées dans le cadre du programme court séjour sur une période de 18 mois. Les données incluaient les réadmissions et les caractéristiques des patients telles que âge, sexe, comorbidités, score ASA (classification de l'état de santé physique selon l'American Society of Anesthesiologists), indice de masse corporelle (IMC) et nombre de médicaments courants.

Résultats : Le taux de réadmission à 30 jours a été de 2,6 % (n = 8). En incluant les cas de conversion en hospitalisation, le taux d'échec global de notre programme court séjour a été de 6,7 % (n = 20). Après ajustement selon un modèle multivarié tenant compte de l'âge, de l'IMC et de la classification de l'ASA, les patients ayant présenté une complication justifiant l'hospitalisation étaient 11,4 fois plus susceptibles d'être réadmis ou hospitalisés (p < 0,001), avec une tendance proportionnelle au nombre de médicaments courants avant l'intervention (p = 0,09).

Conclusion : Le taux actuel de réadmission pour ce programme est comparable aux données publiées antérieurement dans la littérature sur l'arthroplastie. Toutefois, plusieurs patients ont eu besoin d'être hospitalisés, ce qui a eu un impact significatif sur l'efficacité du programme court séjour. Les facteurs de risque de réadmission/conversion ne sont pas entièrement expliqués par les critères de sélection préchirurgicaux actuels. Il faudra continuer d'évaluer le score Blaylock d'estimation des risques pour en déterminer l'utilité à prédire les réhospitalisations.

The last decade has seen many areas of health care attempt to fast-track patient care.[1-3] In surgery, the focus is on enhancing recovery and reducing morbidity by implementing additions or changes, including perioperative pain management, patient education in preparation for surgery, early mobilization and aggressive postoperative fluid administration.[4-7] In orthopedics, shorter hospital stays have been shown to be safe and effective for selected groups of total joint arthroplasty patients.[8-11] A dedicated short stay outpatient arthroplasty program aimed at reducing hospital stay to 36 hours was introduced in 2008 at one of our affiliated hospitals. A review of these patients showed a significant decrease in the length of their hospital stay (LOS).[12]

As successful as these programs have been at reducing hospital stays, some studies have shown higher rates of readmission for their fast-track hip and knee arthroplasty patients. In the total joint arthroplasty population, surgical site infection is a commonly cited reason for hospital readmission, and increasing age is a common risk factor.[13-15] Other causes for readmission cited in the literature include thromboembolic events, anemia, postoperative bleeding requiring transfusion, morbid obesity[2,14,16,17] and psychiatric disorders.[18,19] The clinical evidence would suggest that fast-track, short stay arthroplasty programs are not for every patient and that preselecting and choosing appropriate patients would lead to successful short stay and reduced readmission.[3,8,16,18] Our institution put together criteria and a process to achieve this goal.

The aim of this retrospective comparative study was to determine the overall effectiveness of our short stay program, measured by the 30-day readmission rate and the rate of transfer to inpatient care. We also aimed to identify the most common contributing diagnoses at the time of readmission or hospital transfer. To clarify and improve our screening criteria for a short stay arthroplasty program and minimize events that lead to delayed discharge or readmission, our secondary objective was to determine which patient risk factors were correlated with a higher risk of readmission or transfer. Finally, we wanted to compare our readmission rate to previously published data.

Methods

Primary total hip and knee replacements are performed at 2 affiliated university teaching hospitals, 1 of which has a dedicated short stay outpatient arthroplasty program. The hospital designed for short stays has 8 operating rooms, 2 of which are primarily used by orthopedics. Only 1 total joint arthroplasty room runs on any given day, and there are on average 2 arthroplasty days per week. Orthopedic surgeons participating in the short stay program perform on average 4 primary total joint cases per day. As a predominantly outpatient hospital, the joint replacement unit closes on weekends; therefore, short stay arthroplasties take place only from Monday to Thursday to allow for timely discharges. A multidisciplinary approach is used pre- and postoperatively to streamline discharge within 48 hours and ensure appropriate outpatient supports and follow-up. The short stay program consists of same-day admission for joint replacement surgery followed by an intensive supervised physiotherapy regimen starting immediately after surgery. Patients in this program are discharged home, not to a rehabilitation facility.

Patients must meet predetermined health/fitness criteria as part of a presurgical screening process in order to qualify for the accelerated care program. Since preoperative anemia is a risk factor for postoperative morbidity and mortality, screening includes hematocrit and hemoglobin levels.[20] Patients with diabetes are admissible for the program provided their blood work shows appropriate glycemic control (glycated hemoglobin $HbA_{1c} < 7$). Smokers are advised to quit or cut down before surgery. Patients with atrial fibrillation are also allowed in the program provided their cardiac condition is stable. The current eligibility criteria for the program are as follows: age younger than 85 years, suitable home layout with adequate supports, good functional upper extremity strength, body mass index (BMI) less than 45, primary arthroplasty surgery, American Society of Anesthesiologists (ASA) score less than or equal to 3, normal hematocrit (more than 35%), no history of pulmonary embolism, no previous deep vein thrombosis (DVT) in the last 6 months, no current anticoagulant use (except if used for atrial fibrillation), and no history of rheumatoid or inflammatory arthritis with significant systemic involvement.

On the day of surgery, patients undergo same-day surgery admission, which includes placement of an intravenous line and predetermined weight-based intravenous fluid hydration to maintain euvolemia. Patients preferentially receive a spinal anesthetic (in the absence of contraindication), with judicious use of pre-emptive analgesia, an intraoperative periarticular injection (120 mL solution including 300 mg of ropivacaine with 300 μg of epinephrine, 5–10 mg of morphine, and 15–30 mg of ketorolac), and standardized postoperative pain management. Spinal anesthetic practices consist of appropriately dosed intrathecal bupivacaine and morphine. Bupivacaine is preferred over lidocaine because of its longer duration of action and potentially decreased risk of neurotoxicity.[21] Although bupivacaine has been criticized for its longer duration of motor block and potential to delay postoperative mobilization,[22] this did not significantly affect our postoperative short stay physiotherapy protocol. Primary total joint surgeries are performed by

4 fellowship-trained arthroplasty surgeons and assisted by residents/fellows. Surgeons generally perform total hip arthroplasties using a lateral approach, except for 1 surgeon who uses a posterior approach. Surgeons vary with respect to their use of cemented versus uncemented total hip designs; their preferences are guided by the patient's anatomy and bone quality. For knee arthroplasty, surgeons predominantly use a fixed-bearing resurfacing implant design. Thigh tourniquets are used for all knee arthroplasties to ensure hemostasis throughout the procedure and component implantation. In our study cohort, nonantibiotic-laden bone cement was used for all total knee arthroplasties and all but 1 cemented total hip arthroplasty.

After surgery, patients are transferred to a specialized joint replacement unit, where they follow a clearly defined regimen with early postoperative mobilization beginning the day of surgery. Patients who undergo total hip arthroplasties through a lateral approach follow anterior dislocation precautions (avoidance of external hip rotation with extension), and patients who had the posterior approach follow posterior hip precautions (avoidance of hip flexion with internal rotation). No further restrictions are applied, and patients are encouraged to ambulate, bearing full weight, as soon as they are capable. Physiotherapy services are offered in the evening to account for patients having undergone surgery later in the day. Postoperative fluid management follows a standard postoperative protocol with IV fluid hydration continued until the patient tolerates oral fluids. Fluid input and output is recorded by the nursing team, and in/out bladder catheterization protocols are in place to manage urinary retention. At the time this study was performed, default postoperative thromboprophylaxis consisted of low-molecular-weight heparin (LMWH) prescribed for 14 days for knee arthroplasty recipients or 28 days for hip arthroplasty recipients. Patients who were prescribed warfarin preoperatively received the institutional protocol for preoperative holding/bridging, and postoperatively were prescribed LMWH until a therapeutic international normalized ratio (INR) was achieved on warfarin. Tranexamic acid, which is now administered intraoperatively in these patients, was not being used when this cohort was examined.

Data were collected retrospectively using electronic chart review. A total of 297 charts were manually reviewed. This included all primary total joint arthroplasties completed in the short stay program during an 18-month period. In total, 133 patients underwent a primary total hip arthroplasty, 163 underwent a total knee arthroplasty, and 1 patient had a unicompartmental knee arthroplasty. All surgeries were performed with the patients under a spinal anesthetic, except for 15 hip replacement and 14 knee replacement recipients who received a general anesthetic or required conversion to a general anesthetic owing to incomplete pain blockade.

Every patient admitted to the short stay program had fulfilled the aforementioned screening criteria. Those who did not meet such criteria had their surgery completed at the neighbouring tertiary academic facility and followed a more conventional postoperative course, where the average LOS for arthroplasty patients is 3 days. Data collection included any information pertaining to circumstances of interhospital transfer to inpatient care or readmission if within 30 days of discharge from the primary surgery. We also manually collected data on patient characteristics, such as age, sex, comorbidities, ASA class, BMI and number of preoperative medications. Detailed data pertaining to patient comorbidities were obtained from presurgical screening documents and were stratified into predetermined organ systems. The retrospective nature of this data collection precluded accurate use of a comorbidity scoring system. The readmission diagnoses from our short stay cohort were compared with those of a sample group of consecutive inpatient primary arthroplasty patients who had a readmission to hospital over a similar time period. This comparative group was created from an inpatient readmission database maintained by the senior author. All data were entered into an Excel file and imported into IBM SPSS for statistical analysis. This study was approved by our institute's ethics review board.

Statistical analysis

Following a descriptive analysis, variables associated with readmission or transfer were assessed using χ^2 tests for categorical data and independent samples t tests for continuous data. Variables that showed some association with readmission/transfer ($p < 0.20$) were entered into a multivariable logistic regression model. The standard for statistical significance was $p < 0.05$, but because of the small number of readmissions, the level of significance we used was somewhat more liberal to avoid missing clinically important trends. The number of in-hospital complications during primary admission for the readmission/transfer group were compared with that of the nonreadmission group using χ^2 analyses.

RESULTS

Patient demographic and clinical characteristics and relevant risk factors are listed in Table 1. The 30-day readmission rate was 2.6% ($n = 8$). With the inclusion of patients transferred to the inpatient hospital, the overall failure rate of our short stay program was 6.7% ($n = 20$). Of the 20 patients for whom the short stay program failed, 13 were knee and 7 were hip arthroplasty patients.

Eight patients in the short stay arthroplasty group were readmitted within 30 days with a surgical site complication: 3 hematomas and 5 infections. Patients with postoperative wound hematomas presented 1 week post-

Table 1. Characteristics of short stay program patients by group			
Characteristic	Non-readmission (n = 277)	Readmission (n = 20)	p value
Age, mean ± SD	64.1 ± 9.8	66.8 ± 9.9	0.25
Sex, M:F	121:156	4:16	0.06
BMI, mean ± SD	30.9 ± 5.8	32.5 ± 6.5	0.24
Transfusion rate, %	1	15	0.01
In-hospital complication rate, %	11	65	0.01
No. medications, mean ± SD	3.8 ± 2.7	5.5 ± 3.4	0.01
Anesthetic, spinal:general	265:12	17:3	0.07
BMI = body mass index; F = female; M = male; SD = standard deviation.			

Table 2. Thirty-day readmission diagnosis by group			
Diagnosis	Short stay readmissions, no.	Inpatient group readmissions, no.	p value
Acute coronary syndrome	0	1	0.99
Atrial fibrillation	0	1	0.99
Delirium	0	1	0.99
Gastrointestinal bleed	0	2	0.49
Hematoma	3	1	0.26
Infection	5	4	0.37
Hernia	0	1	0.99
Total readmitted	8	11	

Table 3. Diagnosis for short stay arthroplasty patients requiring inpatient transfer	
Diagnosis	No.
Acute coronary syndrome	4
Atrial fibrillation	1
Chronic obstructive pulmonary disease	1
Delirium	1
Gastrointestinal bleed	1
Hypoxia	1
Mobilization	1
Anemia	1
Weakness	1
Total readmitted	12

operatively and were either treated with aspiration (1 hip) or irrigation/débridement (1 hip and 1 knee) at the surgeon's discretion. Final culture results for all hematomas were negative. Of the 5 documented surgical site infections, 3 were knees and 2 were hips. One of the 3 total knee patients who was readmitted with an infection (*Peptostreptococcus*) required an irrigation and débridement procedure 14 days postoperatively. The remaining 2 patients had superficial infections/cellulitis within 3 weeks of surgery and were treated with antibiotics alone. In the 2 hip arthroplasty patients readmitted for infection, 1 was readmitted 10 days postoperatively with an infected hematoma (coagulase-negative *Staphylococcus*) requiring superficial irrigation and débridement in the operating room. The other patient was readmitted 19 days postoperatively with a deep infection (*S. aureus*) and underwent a single-stage revision procedure. A single-stage procedure was used in this case given the acute (< 3 wk) nature of the infection in an individual who was fit and healthy, and in whom the organism and its sensitivity was clearly defined and was not methicillin-resistant *S. aureus* (MRSA).

Diagnoses at the time of readmission for our short stay patients were compared with those of a group of inpatient primary arthroplasty patients readmitted over a similar time period. Analyses showed no significant differences between the groups on readmission diagnoses, with infection being the most common cause of readmission. There were no significant differences between these 2 groups on age, BMI or sex (Table 2). Of the 20 patients in whom the short stay program failed, 12 had medical complications requiring transfer to the inpatient hospital (Table 3). The details are as follows: 8 patients experienced perioperative cardiorespiratory complications and were transferred to our tertiary acute care centre. Three total knee patients and 1 total hip patient were transferred with a diagnosis of acute coronary syndrome (ACS). Only 1 of these 4 was known to have coronary artery disease; the other 3 had a history of hypertension. One of the patients with ACS underwent

angiography, and the others were treated medically. Two patients were transferred with a diagnosis of hypoxia, which was determined to be associated with exacerbation of chronic obstructive pulmonary disease (COPD). Only 1 of these patients had a known diagnosis of COPD. One patient was transferred with postoperative tachycardia and shortness of breath that was found to be the result of symptomatic anemia (CT pulmonary angiogram was negative for pulmonary embolus), and 1 patient was transferred with new-onset atrial fibrillation and required amiodarone cardioversion. One patient was transferred for an upper gastrointestinal bleed that was treated medically. One patient was transferred for persistent postoperative delirium and underwent a CT scan of the brain that was reported to be normal. Two patients were transferred because of postoperative weakness and failure to mobilize; both had negative workups and their conditions resolved with physiotherapy. A comparison of in-hospital complications for the readmission and non-readmission groups is shown in Table 4.

Risk factors associated with readmission or inpatient transfer on the bivariate analysis included presence of an in-hospital complication during primary admission ($p < 0.001$), transfusion requirement ($p = 0.01$), and higher number of preoperative medications (3.7 ± 2.7 v. 5.5 ± 3, $p = 0.01$). In addition, women exhibited a higher rate of complication leading to readmission or transfer to inpatient care ($p = 0.06$).

Table 4. In-hospital complications among short stay patients by group			
Complication	Readmission/transfer group (*n* = 20), no.*	Non-readmission group (*n* = 277), no.	*p* value
Surgical site			
Hematoma/bleeding	0	3	0.99
Cardiac			
Acute coronary syndrome	4 [4]	0	0.01
New onset atrial fibrillation	1 [1]	0	0.07
Bleeding requiring transfusion	3 [1]	0	0.01
Hypotension	0	1	0.99
Respiratory			
Exacerbation of COPD	1 [1]	0	0.07
Hypoxia	1 [1]	9	
Neurologic			
Delirium	2 [1]	1	0.02
Syncope	0	4	0.99
Gastrointestinal			
Gastrointestinal bleed	1 [1]	0	0.07
Postoperative nausea/vomiting	0	4	0.99
Genitourinary			
Urinary retention	0	4	0.99
Other			
Fever	0	1	0.99
Hyperglycemia	0	1	0.99
Hypomagnesemia	0	3	0.99
Total no. (%)	13 (65.0%)	31 (11.2%)	< 0.001

COPD = Chronic obstructive pulmonary disease
*Numbers in square brackets correspond to in-hospital complications directly responsible for hospital transfer.

Multivariable modelling additionally controlling for age, BMI and ASA score suggested that those with an in-hospital complication were 11.4 times more likely to be readmitted or transferred ($p < 0.001$). There was a trend showing patients to be 1.2 times more likely to be readmitted/transferred with each additional preoperative medication ($p = 0.094$) (Table 5).

DISCUSSION

The 30-day readmission rate in this study (2.6%) is comparable to previously published data from other institutions (range 2.2%–6.51%).[17,23–29] However, the overall failure rate of our short stay program is considerably higher (6.7%) with the inclusion of patients requiring transfer to the inpatient hospital. This is surprising given the extensive preoperative screening carried out in our short stay population. The most common diagnoses complicating our short stay population (SSI, ACS, hematoma) are also reported in other publications in the general total joint arthroplasty literature.[23–28] Nonscreenable risk factors for readmission/transfer identified in this study included in-hospital complication ($p < 0.001$) and transfusion requirement ($p = 0.005$). Risk factors that could be screened for included hematological disease ($p = 0.03$), preoperative number of medications ($p = 0.01$) and female sex ($p = 0.06$). Despite these findings, the current iteration of the screening criteria does

Table 5. Multivariate analysis of selected risk factors for readmission/transfer*		
Risk factor	OR (95% CI)	*p* value
In-hospital complications	11.4 (4.2–31.1)	0.01
Preoperative medications (each additional)	1.2 (0.98–1.4)	0.09

ASA = American Society of Anesthesiologists; BMI = body mass index; CI = confidence interval; OR = odds ratio.
*Adjusted for age, BMI and ASA score.

not account for specific comorbidities (other than thromboembolic events and rheumatoid arthritis), number of comorbidities, or number of medications. A previous study performed by Cunic and colleagues[30] evaluated the use of the Blaylock Risk Assessment Screening Score (BRASS) to predict LOS after elective arthroplasty. The BRASS incorporates age, number of active medical problems and number of medications as part of its calculation.[31] Cunic and colleagues showed that the BRASS was an effective and specific predictor of LOS after elective arthroplasty, with higher scores associated with longer LOS.[30] Although the BRASS is frequently calculated for the arthroplasty population, it is not currently part of our short stay screening criteria. Of the 20 readmission cases, 9 patients had the BRASS documented in the electronic chart. The average and median score was 5 (range 2–8). Further evaluation of the BRASS is required to determine its ability to predict

readmission after elective arthroplasty as well as its suitability as a screening tool for the short stay program.

After infection, postoperative ACS was the second most common complication resulting in readmission or inpatient transfer, with only 1 in 4 patients having a known history of coronary artery disease. Recent studies and meta-analyses have evaluated the use of preoperative plasma natriuretic peptide levels (B-type natriuretic peptide or N-terminal pro-BNP) and have determined that it is a low-cost alternative to cardiac stress testing and a strong predictor of cardiac events in the 30-day postoperative period after major noncardiac surgery.[32,33] Further evaluation of this screening test in the arthroplasty population is required while considering future iterations of our short stay eligibility criteria.

Postoperative hematoma was the third most common cause of readmission/transfer in our cohort, accounting for 15% of all cases. As previously mentioned, this study was performed before the advent of tranexamic acid use in total joint arthroplasty and its implementation at our institution. Both topical and intravenous formulations of intraoperative tranexamic acid have been shown to decrease postoperative low hemoglobin and transfusion after total joint arthroplasty.[34] We suspect that our reported rates of postoperative transfusion, hematoma and associated infections may have decreased since the adoption of new practices at our institution, including the use of intraoperative tranexamic acid, as well as the recent shift among our orthopedic surgeons to using acetylsalicylic acid instead of LMWH for postoperative thromboprophylaxis in low-risk individuals.

Our short stay arthroplasty cohort as a whole experienced a low rate of postoperative nausea/vomiting (1.3%), which may be attributable to the preference for neuraxial anesthesia and low rates of general anesthesia.[35] Urinary retention has also been reported as a common complication following total joint arthroplasty with a potential for increasing LOS.[34] Rates of urinary retention after total joint arthroplasty have been quoted to be as high as 84% in certain studies, with the use of spinal anesthesia almost doubling this risk.[36] However, despite 89.3% of our patients receiving a spinal anesthetic, the urinary retention rate in our cohort was only 1.3%. This may be attributable to better pain control, close monitoring of urinary output by our nursing staff and standardized orders for intermittent catheterization. Neither postoperative nausea/vomiting nor urinary retention were associated with increased LOS in our study.

Limitations

There were notable limitations to this study. As a retrospective study, we could not account for the possibility that some patients may have been readmitted to other institutions outside of our local hospital network. This possibility is less likely, however, given the structure of the health care delivery in our region. Patients presenting to neighbouring community hospitals with postoperative complications are commonly repatriated to the primary surgical facility for evaluation by the orthopedic surgery team. Although diagnoses on readmission for our short stay patients were similar to those of our inpatient arthroplasty population, this comparison is somewhat limited because of the general tendency of our inpatients to be less healthy, having failed to meet the short stay criteria.

Our risk factor analysis included 12 patients who could not be discharged home from the short stay program because of a medical complication or a failure to mobilize, requiring transfer to an inpatient unit. Although these patients do not strictly fit the definition of readmission, they are nonetheless vital for evaluating the effectiveness of a short stay arthroplasty screening program. Considerable costs are incurred during interhospital patient transfer, which also places considerable burden on the often overpopulated inpatient orthopedic ward. For this reason, the aforementioned transferred patients were included in our analysis.

Conclusion

The short stay outpatient arthroplasty program provides a physiotherapy-intensive plan for low-risk patients to decrease LOS. Current readmission rates from our program are comparable to previously published data (2.6%). Risk factors for failure in the short stay program are not completely accounted for by current presurgical screening criteria (number of medications, hematological disease). Further evaluation of scoring systems such as the BRASS may be of value for predicting hospital readmission.

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