

Research Article

Number of Stairs at Home is Associated with Discharge to Post-Acute Care Facility Following Total Knee Arthroplasty

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Background

Discharge to post-acute care facility (PACF) carries significant cost and quality burdens to patients undergoing total knee arthroplasty (TKA). In a recent study of pre-bundled payment model patients, the number of stairs (NOS) at home did not influence discharge to PACF for total hip arthroplasty. However, no study has yet examined NOS as it relates to discharge destination after TKA. In a large metropolitan market, it is not uncommon to have several flights of stairs leading to a home. We hypothesize that the number of unavoidable stairs to enter a home is a significant risk factor for discharge to PACF.

Methods

We reviewed 557 patients who underwent elective TKA at a single urban academic medical center between November 2011 and October 2014. Demographic data as well as NOS, ASA score, RAPT score, LOS, operative time, and tranexamic acid use were collected. T-tests, ANOVA, and Kruskal-Wallis analysis were conducted followed by a logistic regression to compare associations of factors to discharge to PACF.

Results

Of the 540 patients included in analysis, 193 (35.7%) were discharged home and 347 (64.3%) were discharged to a PACF. NOS (OR=1.457, p<0.001) and increased age

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(OR=1.057, $p<0.001$) were found to be significant risk factors for discharge to PACF while female sex (OR=0.57, $p=0.013$) and higher RAPT scores (OR=0.83, $p=0.004$) were protective against discharge to PACF.

Conclusion

With the conclusion of recent bundled payment programs, financial carrots may disappear, though it is likely that sticks will remain. Therefore, all risk factors must be identified and addressed. We found, in a pre-bundled payments era, that stairs is a risk factor for non-home discharge in a metropolitan population, and we confirmed other known risk factors of older age, higher ASA score, and lower RAPT score.

INTRODUCTION

Discharge to post-acute care facilities (PACFs) following total joint arthroplasty (TJA) represents a significant cost burden following TJA. Post-discharge costs have been reported as high as 35% of total episode of care spending, especially PACF cost, which can represent 70% of post-discharge care (Bozic et al. 2014). Centers for Medicare and Medicaid Services (CMS) instituted alternative payment models, including the Comprehensive Care for Joint Replacement (CJR) and the Bundled Payment for Care Improvement Advanced (BPCI-A), in many metropolitan areas. Such bundling payment models financially incentivized discharge to home rather than to costly PACFs (Finkelstein et al. 2018). Home discharge is also associated with lower 30-day and 90-day readmission rates (Ramos et al. 2014; Bini et al. 2010).

Value-based care initiatives continue to persist in healthcare policy discussions even after the initial bundle programs have ended. In the next generation of models, risk stratification, which considers patient-specific factors before assigning a bundle, will be of paramount importance. Therefore, all possible risk factors for non-home discharge must be identified. Known risk factors for PACF discharge include older age, female sex, non-Caucasian race/ethnicity, lower socioeconomic status, unemployment status, slower pre-operative Get Up and Go scores (TGUG), lower pre-operative EQ-5D scores, higher American Society of Anesthesiologists (ASA) scores, and increased hospital length of stay (LOS) (Munin et al. 1995; Inneh 2015; Morrow-Howell and Proctor 1994; Fang et al. 2020; Sharareh et al. 2014).

Few studies have evaluated physical logistical barriers to patients returning home after total knee arthroplasty (TKA), particularly, the number of unavoidable stairs (NOS) required to enter and navigate one's home. The NOS is an important metric as stairs can pose a significant physical challenge to patients being discharged home safely following TKA; but it has not been thoroughly studied and has not been shown to influence disposition after surgery (Wyatt, Beard, and Busuttil 1999; Smith et al. 1994; Hamel and Cavanagh 2004). Intuitively, a patient living on the 6th floor of a non-elevator building has a major physical challenge to going home, and it is logical that such a living arrangement would influence the likelihood of discharge to PACF. The influence of "walk-up" buildings may be regional, but there are no current stratifications by CMS or by common predictive tools to account for the number of stairs at home.

The Risk Assessment and Prediction Tool (RAPT) is a commonly used method of predicting the discharge destination and length of stay (LOS) for patients after TJA (Sconza et al. 2019). However, this tool, along with other established risk evaluators, does not include NOS in the assessment (Wang et al. 1998; Bindelglass et al. 1999).

Singh et al. evaluated the number of stairs to enter a home and its relationship to LOS, patient reported outcome measures (PROMs), and discharge disposition following TJA (Singh et al. 2021). The authors only measured stairs to enter home and evaluated patients after the implementation of bundled payment models in a period from 2016 to 2020 when novel interventions were implemented to improve home discharge. Murtaugh et al. studied the number of unavoidable stairs at home in total hip replacement patients in a pre-bundled payment era and in a metropolitan population (Murtaugh et al. 2022). The authors, with the number available, did not find a correlation between the number of stairs and discharge to PACF. Knee replacement recovery differs from, and is generally considered more difficult than, hip replacement recovery. Therefore, an association between stairs and TKA discharge may exist, whilst none was found for hip patients.

In this study, we evaluated the risk factors associated with disposition to a PACF following elective TKA with a focus on the number of unavoidable stairs required to enter and navigate the patient's home. We hypothesize that the number of unavoidable stairs to enter a home is a significant risk factor for discharge to PACF after TKA, and therefore must be considered in markets with "walk-up" buildings.

MATERIALS AND METHODS

Following approval by our institutional review board, we retrospectively reviewed 557 patients who underwent elective total knee arthroplasty at a single urban academic medical center between November 2011 and October 2014. As such, all operations preceded the implementation of CMS-mandated bundled-payment models at our institution and before any novel interventions were implemented to get patients home after TKA (such as longer in-hospital stays, different pain medications, encouraging discharge to a family member's elevator-building home, etc). At that time, standard preoperative and surgical educational materials were provided to all patients by the same preoperative educator. Physical therapy goals and discharge plans were also reviewed with patients preoperatively. All surgeries

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Table 1. Demographics based upon discharge disposition.

Demographics	Home (n=193)	PACF (n=347)	P-value
Age ($\pm$ SD, range)	64.7 ($\pm$ 10.2, 19-84)	71.4 ($\pm$ 9.7, 35-94)	<0.001*
Sex (% Females)	121 (63.3%)	262 (75.8%)	0.002*
BMI ($\pm$ SD, range)	31.0 ($\pm$ 7.6, 18.4-66.2)	31.2 ($\pm$ 6.5, 18.1-58.2)	0.78
ASA ($\pm$ SD, range)	2.3 ($\pm$ 0.5, 1-4)	2.4 ($\pm$ 0.5, 1-4)	0.001*
RAPT ($\pm$ SD, range)	9.8 ($\pm$ 1.5, 4-12)	8.5 ($\pm$ 2.1, 1-12)	<0.001*
LOS ($\pm$ SD, range)	3.4 ($\pm$ 1.1, 0.13-12.2)	3.8 ($\pm$ 2.2, 0.2-33.2)	0.023*
Tranexamic Acid (% Yes)	94 (49.0%)	171 (49.3%)	0.94
Operative Time ($\pm$ SD, range)	109.5 ($\pm$ 21.7, 74-215)	109.7 ($\pm$ 21.6, 48-198)	0.89
Number of stairs at home	7.5 ($\pm$ 8.4, 0-48)	10.1 ($\pm$ 11.9, 0-60)	0.008*

* denotes significance

were performed by two senior fellowship-trained arthroplasty surgeons via a standard medial parapatellar approach. Postoperatively, patients received physical therapy twice daily and occupational therapy once daily. Social workers began planning discharge arrangements on post-operative day one considering physical therapy milestones and home environment features, including the number of unavoidable stairs at home. Patients discharged home were provided with home care services including visiting nursing and physical therapy.

Seventeen patients were excluded from the study due to missing data and bilateral surgery, leaving 540. Patients were stratified by discharge destination, either home with services (n=193, 35.7%) or PACF (n=347, 64.3%). Patient demographics and other factors including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, Risk Assessment and Prediction Tool (RAPT), length of hospital stay (LOS), tranexamic acid (TXA) use, operative time, and number of unavoidable stairs at home (NOS) are shown in [Table 1](#).

A descriptive statistical analysis was conducted to provide baseline demographic data. A paired student's t-test was used to analyze continuous factors and chi-square test for categorical variables. When comparing samples with more than 2 variables, ANOVA (continuous variables) and Kruskal-Wallis (categorical variables) were used to assess significance ($p < 0.05$). Significant factors included Sex, Age, LOS, NOS, ASA, RAPT, ([Table 1](#)). A logistic regression was run using all significant variables from the first analysis to identify factors predictive of discharge to PACF ([Table 2](#)).

Finally, patients were stratified into 3 groups (those with 0, 1-10 stairs, and greater than 10 stairs) to evaluate how each segment affects discharge destination. This analysis is shown in [Table 3](#). All analyses were performed using SPSS version 28.

RESULTS

Of the 540 patients included in the study, 193 (35.7%) were discharged home and 347 (64.3%) were discharged to a PACF. Regarding demographic characteristics, BMI, TXA use, and operative time were not significantly associated with discharge destination. Patients discharged to PACFs were generally of greater age ($p < 0.001$), more often female ($p = 0.002$), had higher ASA scores ($p = 0.001$), lower RAPT scores ($p < 0.001$), greater LOS ($p = 0.023$), and greater number of unavoidable stairs at home ($p = 0.008$).

In the logistic regression, male sex ($p = 0.013$), greater age ($p < 0.001$), higher number of unavoidable stairs ($p < 0.001$), and higher RAPT score ($p = 0.004$) were significantly associated with being discharged to a PACF. LOS ($p = 0.145$), and American Society of Anesthesiologists score ($p = 0.055$) were not significant ([Table 2](#)).

When stratified into three groups by number of stairs (no stairs, 1-10 stairs, and >10 stairs), age ($p = 0.001$), sex ($p = 0.007$), RAPT score ($p < 0.001$), and number of unavoidable stairs ($p < 0.001$) were significantly different among groups. Average ages were 71.3, 67.1, and 68.5 for the no stairs, 1-10 stairs, and >10 stairs, respectively. There were 128, 112, and 157 females in the no stairs, 1-10 stairs, and

Table 2. Logistic Regression. Predictors of discharge to PACFs.

Variable	Std. Err.	p-value	Odds ratio	95% CI	
				Lower	Upper
Sex(female)	0.228	0.013*	0.57	0.365	0.89
Age	0.012	<0.001*	1.057	1.033	1.082
LOS	0.093	0.145	1.145	0.954	1.374
Stairs	0.011	<0.001*	1.457	0.992	2.141
ASA	0.196	0.055	1.735	1.188	2.534
RAPT	0.065	0.004*	0.83	0.732	0.943

* denotes significance.

Table 3. Demographics based upon number of unavoidable stairs.

Demographics	No Stairs (n=163)	1-10 Stairs (n=139)	>10 Stairs (n=238)	p-value
Age (±SD, range)	71.3 (±10.4, 44-91)	67.1 (±10.9, 19-92)	68.5 (±9.9, 35-94)	0.001*
Sex (% Females)	128 (78.5%)	112 (57.4%)	157 (66%)	0.007*
BMI (±SD, range)	30.9 (±8.4, 19.5-66.2)	31.5 (±6.2, 18.1-49.4)	31.2 (±6.3, 18.2-58.2)	0.808
ASA (±SD, range)	2.3 (±0.5, 1-4)	2.3 (±0.5, 1-4)	2.4 (±0.5, 1-4)	0.113
RAPT (±SD, range)	8.3 (±2.1, 1-12)	9.4 (±2, 2-12)	10.2 (±0.1.7, 5-12)	<0.001*
LOS (±SD, range)	3.6 (±1.5, 0.1-13.9)	3.7 (±1.7, 1.5-20.1)	3.7 (±2.2, 0.2-33.2)	0.836
Operative Time (±SD, range)	109.4 (±19.2, 71-165)	107.5 (±23.8, 64-215)	111.3 (±22.1, 48-198)	0.366
Unavoidable Stairs	0	4.3 (±2.5, 1-10)	18.4 (±10.3, 11-60)	<0.001*
TXA (%Yes)	79 (48.5%)	61 (43.9%)	125 (52.5%)	0.316

* denotes significance.

Table 4. Discharge Disposition by the Number of Unavoidable Stairs.

Discharge Destination	No Stairs (n=163)	1-10 Stairs (n=139)	>10 Stairs (n=238)	p-value
Discharge to PACF (%)	101 (62%)	82 (59%)	164 (68.9%)	0.102

>10 stairs, respectively. Average RAPT scores were 8.3, 9.4, and 10.2 for the no stairs, 1-10 stairs, and >10 stairs, respectively. Average NOS were 0, 4.3, and 18.4 in the no stairs, 1-10 stairs, and >10 stairs, respectively (Table 3).

The rate of discharge to PACF was not significantly different among stratification groups ($p=0.102$), with 101, 82, and 164 patients being discharged to PACF in the no stairs, 1-10 stairs, and >10 stairs, respectively (Table 4).

DISCUSSION

In this study, we examined factors associated with discharge to PACFs following TKA with a focus on number of unavoidable stairs at home (NOS). We found greater NOS, male sex, greater age, and lower RAPT score to be significant risk factors for discharge to PACF in our urban academic setting. To our knowledge, this is the first study to identify the number of unavoidable stairs as a risk factor for discharge to PACF, using a cohort of patients from a met-

ropolitan market that is known for “walk-up” apartment buildings lacking an elevator.

Understanding risk factors associated with discharge to PACF is a necessary step in designing appropriate risk-stratification algorithms. Known risk factors for discharge to PACF include older age, female sex, non-Caucasian race/ethnicity, lower socioeconomic status, unemployment status, slower pre-operative Get Up and Go scores (TGUG), lower pre-operative EQ-5D scores, higher American Society of Anesthesiologists (ASA) scores, lower RAPT scores, increased hospital length of stay (LOS), increased self-reported post-operative pain, and decreased physical therapy achievements (Munin et al. 1995; Inneh 2015; Morrow-Howell and Proctor 1994; Fang et al. 2020; Sharareh et al. 2014; Inneh et al. 2016). This study affirms older age, higher ASA scores, and lower RAPT scores as risk factors, but found female sex to be protective. Additionally, greater number of unavoidable stairs at home was found to be a new risk factor for discharge to PACF in our patient sample, confirming our hypothesis and identifying another en-

vironmental characteristic to explore in the effort to properly risk-stratify TKA.

We hypothesized that the number of unavoidable stairs in the household would be a risk factor for discharge to PACF. This study supports our hypothesis and suggests that a higher NOS encourages clinical and physical therapy staff to discharge patients to PACF. Stairs can be a challenging post-operative obstacle for TJA patients. For example, a patient in a large metropolitan city may live on an upper floor of a building without an elevator. Alternatively, a patient may have to navigate stairs to reach a bathroom or kitchen during recovery. However, there is no available evidence that NOS has an impact on readmissions, patient satisfaction (Singh et al. 2021) or mortality when patients are discharged home. Patients are generally provided with select services when discharged home following TKA which can provide assistance. Family members, friends, and/or other temporary logistical shortcuts around the home may further compensate for NOS during the recovery period.

The RAPT score was weakly predictive of discharge location. RAPT scores generally indicate 3 different discharge options. Scores below 6 indicate discharge to PACF, scores 6-9 are intermediate such that a patient could be discharged to home (likely with extra services) or to a PACF, and scores greater than 9 indicate a home discharge (Sconza et al. 2019). In this study, patients discharged home versus to PACF averaged a RAPT score of 9.8 versus 8.5, respectively. The 8.5 average of those discharged to PACF sits toward the upper limit of the intermediate zone, suggesting other factors were contributing to patients being discharged to PACFs.

Identifying all risk factors for PACF discharge can help reduce costs by focal targeting of those risk factors. By 2024, healthcare expenditure is expected to increase to 19.6% of gross domestic product, significantly higher than other comparable countries (Keehan et al. 2015). Such unsustainable increases have prompted initiatives geared towards decreasing costs across all healthcare industries and specialties. As such, it is important to identify modifiable drivers of cost within specialties and procedures. Total joint arthroplasty is the largest Medicare procedural cost at 6.3%, making it a likely target for further cost-saving initiatives. Care at PACFs accounts for 35% amount of the total cost burden associated with total knee arthroplasty (Bozic et al. 2014). In more traditional fee-for-service (FFS) payment models, financial incentives encouraged more discharges to PACFs, as such discharges had no consequence to the

hospital and may actually improve relationships between hospitals and outpatient care facilities. It is unclear, however, whether outcomes are better overall for patients discharged to PACFs compared to home discharges. Keswani et al. found that discharge to skilled nursing facilities and inpatient rehabilitation facilities increased the risk for post-discharge adverse events compared to home discharge (Keswani et al. 2016). Bini et al. found that TJA patients that were discharged to skilled nursing facilities had higher odds of 90-day readmission compared to patients discharged home (Bini et al. 2010). Ponnusamy et al. found that inpatient rehabilitation following TJA had increased costs of a median value of \$30,000 compared to patients discharged home (Ponnusamy et al. 2017). Therefore, reserving discharges to PACFs only for select patients may be an important method of mitigating rising costs associated with TKA.

This study has certain limitations to consider. First, it was conducted at a single large academic center in a metropolitan setting which may limit its generalizability across institutions and in other environments like rural and suburban settings. Second, the retrospective nature of the study creates limitations, including potential confounding factors. Third, our patient sample was collected prior to the implementation of both CJR and BPCI initiatives. We believe this isolated selection limits the confounding from cost-saving initiatives and is a strength; however, the modern interactions between CJR, BPCI, and NOS in practice is not observable in this study. Finally, the accuracy of data collection for our main factor of interest, number of unavoidable stairs at home, is difficult to ensure. For example, patients may round or estimate the NOS, or include avoidable stairs when reporting the NOS.

The number of unavoidable stairs at home is shown here to be a risk factor for discharge to PACF in total knee arthroplasty. This finding, in light of the lack of evidence supporting efficacy of PACFs, is important both for discharge planning on an individual basis, and for the broader efforts to decrease healthcare spending. Most importantly, stairs can be considered in risk stratification algorithms. This study also supports existing literature in its affirmation of older age, higher ASA scores, and higher RAPT scores as risk factors for discharge to PACFs.

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