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# Who Goes to Inpatient Rehabilitation or Skilled Nursing Facilities Unexpectedly Following Total Knee Arthroplasty?

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ABSTRACT

*Background:* Inpatient rehabilitation facilities (IRFs) and skilled nursing facilities (SNFs) represent a significant portion of post-operative expenses of bundled payments for total knee arthroplasty (TKA). Although many surgeons no longer routinely send patients to IRFs or SNFs, some patients are unable to be discharged directly home. This study identified patient factors for discharge to post-acute care facilities with an institutional protocol of discharging TKA patients home.
*Methods:* A retrospective review of patients undergoing primary unilateral TKA at a single institution from 2012 to 2017 was performed. All surgeons discharged patients home as a routine protocol. An electronic query followed by manual review identified discharge disposition, demographic factors, co-morbidities, and other patient factors. In total, 2281 patients were identified, with 9.6% discharged to SNFs or IRFs and 90.4% discharged home. Univariate and multivariate analyses were conducted to create 2 predictive models for patient discharge: pre-operative visit and hospital course.
*Results:* Among 43 variables studied, 6 were found to be significant pre-operative risk factors for a discharge disposition other than home. In descending order, age 75 or greater, female, non-Caucasian race, Medicare status, history of depression, and Charlson Comorbidity Index were predictors for patients going to IRFs. In addition, any in-hospital complications led to a higher likelihood of being discharged to IRFs and SNFs. Both models had excellent predictive assessments with area under curve values of 0.79 and 0.80 for pre-operative visit and hospital course.
*Conclusion:* This study identifies pre-operative and in-hospital factors that predispose patients to non-routine discharges, which allow surgeons to better predict patient post-operative disposition.


Total knee arthroplasty (TKA) is among the most common elective procedures performed worldwide and, as such, has become the target of both national and global cost containment efforts [1]. With the transition to bundled payments, it is crucial to minimize unnecessary expenses. It has been established that as much as 36% of TKA related expenses occur in the post-operative period, of which 70% represent expenses related to post-acute care facilities [2]. Thus, healthcare policy makers and hospital administrators are increasingly focused on disposition planning and execution.

Historically, it was common for patients to be discharged to inpatient rehabilitation facilities (IRFs) following TKA. Advocates of this approach cited increased safety and guidance provided by therapists and staff [3,4]. However, in recent years an abundance of literature has consistently shown that outcomes for patients sent to IRF may be worse and that IRF stays are costly [2,5–7].

Due to increased cost containment efforts and concern for deleterious outcomes, many surgeons are routinely opting against sending their post-operative patients to IRFs [8]. At our institution, arthroplasty surgeons are no longer recommending discharge to skilled care facilities. Despite this change in protocol and peri-operative assistance from patient navigators, many patients are still unexpectedly discharged to skilled nursing facilities (SNFs) and IRFs. Thus, it is important to elucidate which patients are likely to

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**Table 1**
Demographic Data and Univariate Analysis of Patients Undergoing TKA Stratified by Post-Hospital Disposition.

| | Rehabilitation (n = 218) | Home (n = 2063) | *P*-Value |
|---|---|---|---|
| Age (y) | 73.8 (0.62) | 65.7 (0.20) | <.001 |
| Gender (male) | 45 (20.6) | 880 (42.7) | <.001 |
| BMI (kg/m$^2$) | 30.4 (0.37) | 31.3 (0.12) | .028 |
| CCI | 0.75 (0.08) | 0.50 (0.02) | <.001 |
| Insurance status (Medicare) | 160 (73.4) | 921 (45.9) | <.001 |
| Laterality (right) | 114 (52.3) | 1086 (52.7) | .943 |
| Race (non-Caucasian) | 74 (34.9) | 409 (20.2) | <.001 |
| Smoker | 7 (3.2) | 138 (6.7) | .056 |
| History of depression | 43 (19.7) | 285 (13.8) | .020 |
| In-hospital complication[a] | 37 (17.0) | 123 (6.0) | <.001 |
| Cardiac complication[b] | 7 (3.2) | 23 (1.1) | .020 |
| Cerebral complication[c] | 5 (2.3) | 10 (0.5) | .010 |
| Shock | 4 (1.8) | 19 (0.9) | .269 |
| Post-operative hemorrhagic anemia | 20 (9.2) | 41 (2.0) | <.001 |
| Fluid, electrolytic imbalance | 9 (4.1) | 21 (1.0) | .001 |
| LOS | 3.4 (0.15) | 2.0 (0.02) | <.001 |
| Procedure duration (min) | 76.2 (1.41) | 74.7 (0.46) | .331 |

Data represented as mean (standard error) or number (percentage).
[a] More than 1 complication occurred in certain patients. There were 15 and 30 patients with more than 1 in-hospital complication in the rehabilitation and home cohorts, respectively.
[b] Cardiac complications included acute myocardial infarction, congestive heart failure, conduction arrhythmias, and aortic dissection.
[c] Cerebral complications included cerebrovascular accident, altered mental status, and nerve disorders.

require post-acute care facilities. Identifying this population may allow surgeons to better manage patient expectations pre-operatively and minimize complications associated with inpatient rehabilitation stays.

The aims of this study are thus to identify patient factors and create a calculator for unexpected discharge to post-acute care facilities after primary TKA with an institutional protocol of discharge to home.

## Materials and Methods

After Institutional Review Board approval, a retrospective review of patients undergoing primary TKA at a single institution from 2012 to 2017 was performed. An electronic chart query was utilized to identify patients' disposition following hospital course. Inclusion criteria for this study comprised patients undergoing elective unilateral primary TKA with documentation of post-operative discharge location of home, home health, IRF, and SNF. Patients discharged to home health were allocated to the "discharge to home" cohort. Patients with simultaneous bilateral TKA, revision TKA, and traumatic indication for TKA were excluded from the study. Patients of attending surgeons who routinely discharge patients to IRFs or SNFs or allow patients a choice in their desired discharge destination were excluded. The patients included in this study were from surgeons where the pre-operative expectation was to go home in over 95% of patients.

Another electronic query was then performed followed by a manual chart review for date of admission, date of discharge, in-hospital complications, co-morbidities, insurance information, procedure duration, and demographic information resulting in a total of 2281 patients. Patient co-morbidities were assessed using the Charlson Comorbidity Index (CCI) [9] (Appendix I). Information regarding smoking and drug use was electronically obtained from anesthesia records. Patients discharged to post-acute care facilities represented 9.6% (218/2281), while patients discharged to home represented 90.4% (2063/2281) of the cohort. Demographic data for the patient cohort are shown in Table 1. In-hospital complications (venous thromboembolic, cardiac, pulmonary, gastrointestinal, cerebral, vascular, infection, intra-operative, and renal) were assessed.

The study period was chosen to include patients after a transition to routinely discharging TKA patients to home. During the informed consent process, all patients were informed that they were expected to be discharged home and underwent primary TKA with this expectation. All TKAs were performed through a medial parapatellar approach. Spinal anesthesia was the preferred method of anesthesia with general anesthesia used if spinal anesthesia failed or was not possible. Discharge disposition was based on the recommendation of a physical therapist who evaluated the patient on the day of surgery, and twice a day afterwards.

### *Statistical Analysis*

Descriptive statistics are presented throughout the text as means (standard errors), counts (percentages), or percentages (numerator/denominator). Preliminary univariate analyses (consisting of chi-squared tests for categorical variables and t-tests for independent groups for continuous variables) were conducted to compare the group of patients discharged home vs those discharged to IRFs on each of the patient background variables. Patient variables which differentiated the groups in the univariate analyses ($P < .2$) were included in the final patient predictive models, whereas all hospital/operative variables were included in the second predictive model given there were so few available predictors [10]. Note that body mass index (BMI) and length of stay (LOS) had to be excluded from the final models due to serious multi-collinearity their inclusion created.

To determine the relative contribution of patient and hospital variables in predicting discharge status (rehabilitation vs home), 2 logistic regression models were conducted. A pre-operative visit model consists of patient variables including age 75 years or older, Medicare insurance status, CCI, male gender, Caucasian race, and history of depression. The second model was composed of hospital or operative variables including any in-hospital complication and procedure duration in addition to patient variables (age 75 years or older, Medicare insurance status, CCI, male gender, Caucasian race, and history of depression). Two models were created in order to allow surgeons to predict patient disposition pre-operatively using patient-related factors and with peri-operative factors.

**Table 2**
Pre-Operative Visit Predictive Model of Patient Post-Hospital Disposition Following Primary TKA.

| | Beta | *P* Value |
|---|---|---|
| Pre-operative visit predictive model | | |
| Age ≥75 | 1.425 | <.001 |
| Insurance status (Medicare) | 0.707 | <.001 |
| CCI[a] | | |
| DM, liver disease, solid tumor, AIDS, moderate to severe CKD, CHF, MI, CPD, CVA, or TIA, dementia, hemiplegia, connective tissue disorder, leukemia, malignant lymphoma, PUD, PVD | 0.264 | <.001 |
| Gender (male) | −0.966 | <.001 |
| Race (Caucasian) | −0.937 | <.001 |
| History of depression | 0.551 | .006 |
| Constant | −2.408 | – |

Equation for odds ratio of disposition to inpatient rehabilitation facility: Expˆ[−2.408 + 1.425 (age ≥75) + 0.707 (insurance status (Medicare)) + 0.264 (CCI) + −0.966 (gender (male)) + −0.937 (race (Caucasian)) + 0.551 (depression)]. DM, diabetes mellitus; AIDS, acquired immunodeficiency syndrome; CKD, chronic kidney disease; CHF, congestive heart failure; CPD, chronic pulmonary disease; CVA, cerebrovascular accident; TIA, transient ischemic attack; MI, myocardial infarction; PUD, peptic ulcer disease; PVD, peripheral vascular disease.
[a] Methodology to calculate CCI listed in Appendix I.