Risk Factors for Discharge to Rehabilitation Among Hip Fracture Patients

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Abstract

Length of stay (LOS) drives costs for hip fracture patients. One factor that affects LOS is delayed transfer of patients to rehabilitation centers. It is therefore imperative that orthopedists have a mechanism for identifying which patients require rehabilitation services after surgery.

We conducted a study to identify patient risk factors that are significantly associated with discharge to rehabilitation. Using 2011 ACS-NSQIP (American College of Surgeons National Surgical Quality Improvement Program) data, we prospectively analyzed the cases of 4815 patients who underwent hip fracture surgery and had discharge information available. Discharge location, surgery type, patient demographics, 32 patient comorbidities, and 7 operative factors were identified in these patients. Fisher exact tests were used to determine which patient factors were significantly associated with discharge to rehabilitation.

Of the 4815 patients, 80.3% were discharged to rehabilitation and 19.7% to home. After multivariable analysis, age over 65 years, female sex, dialysis, prior percutaneous coronary intervention, hypertension, general anesthesia, and ASA (American Society of Anesthesiologists) class higher than 2 had higher odds of discharge to rehabilitation, and DNR (do not resuscitate) status had higher odds of discharge to home.

This study was the first to determine which factors predicted discharge to rehabilitation in hip fracture patients. Knowing these risk factors provides orthopedists with a mechanism that can be used to identify which patients require rehabilitation after surgery, thereby facilitating transfer and potentially decreasing LOS and associated costs.

Length of stay (LOS) is a significant driver of costs after hip fracture surgery.[1-3] Multiple studies have identified factors associated with increased LOS in hip fracture patients. These factors include admission time, delay to surgery, presence of comorbidities, and older age.[4-9]

One significant and potentially modifiable factor affecting LOS is delayed transfer to a rehabilitation center after surgery.[8-11] Although patients after orthopedic surgeries require additional rehabilitation services or subacute care directly attributable to their injuries, specialized rehabilitation centers may not always have beds readily available.[6-11] Studies have shown that delays in transfer to skilled nursing facilities or rehabilitation centers are highly common among orthopedic patients.[8] It is therefore imperative that orthopedists have a mechanism for predicting and identifying which patients require rehabilitation services early in the postoperative period. Identifying risk factors and stratifying patients who are most likely to require rehabilitation would facilitate the early transfer of these patients and thereby directly decrease LOS and hospitalization-related costs.

In this article, we report results from prospective, national, multicenter data to identify commonly measured risk factors for discharge to rehabilitation facilities for hip fracture patients. Through multivariate analysis of ACS-NSQIP (American College of Surgeons National Surgical Quality Improvement Program) data, we determined which risk factors significantly predispose patients to discharge to rehabilitation centers versus discharge home. Knowledge of these risk factors allows the practicing orthopedist to be better equipped to identify patients who require additional rehabilitation early in the postoperative course. By mobilizing case managers and social workers to help avoid delays in the transfers of these identified patients, LOS-associated costs may ultimately decrease.

Materials and Methods

After obtaining institutional review board approval for this study from the Office of Research at Vanderbilt University, we prospectively collected 2011 discharge data from the ACS-NSQIP database (these data are unavailable for earlier years). All patients who underwent hip fracture surgery in 2011 were

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identified by CPT (*Current Procedural Terminology*) codes. Cases of patients with unknown discharge information and of those who died during their hospitalizations were excluded from analysis. For the remaining patients, discharge information as categorized by ACS-NSQIP included skilled care (eg, subacute hospital, skilled nursing home), unskilled facility (eg, nursing home, assisted facility), separate acute care, and rehabilitation. All other patients were discharged home without additional assistance or to the previous home where they received chronic care, assisted living, or unskilled aid. Patients were dichotomized according to whether they were discharged home or to one of the rehabilitation facilities mentioned.

To determine which risk factors significantly contributed to a patient's discharge to rehabilitation, we ran univariate analyses using Fisher exact tests for categorical variables and Student t tests for continuous variables on multiple patient factors, including demographics, preoperative comorbidities, and operative factors. Demographics included age and sex. Preoperative comorbidities included 32 conditions: diabetes mellitus, active smoking status, current alcohol use, dyspnea, history of chronic obstructive pulmonary disease, history of congestive heart failure, hypertension requiring medication, history of esophageal varices, history of myocardial infarction, current renal failure, current dialysis dependence, steroid use, recent weight loss, existing bleeding disorder, transfusion before discharge, presence of central nervous system tumor, recent chemotherapy, recent radiation therapy, previous percutaneous coronary intervention, previous percutaneous coronary stenting, history of angina, peripheral vascular disease, cerebrovascular accidents, recent surgery (within 30 days), rest pain, impaired sensorium, history of transient ischemic attacks, current hemiplegia status, current paraplegia status, current quadriplegia status, current ascites, hypertension, and disseminated cancer. Operative factors included wound infection, DNR (do not resuscitate) status, ventilator support, anesthesia type, wound class, ASA (American Society of Anesthesiologists) class, and operative time.

For the univariate analyses, significance was set at $P < .05$. Demographics, preoperative comorbidities, and operative factors that were significantly associated with discharge to a rehabilitation facility in the univariate analysis were selected as covariates for a multivariate analysis. We incorporated a binary logistic regression to analyze which of these significant risk factors are correlated with a patient's discharge to a rehabilitation facility after hip fracture surgery.

Results

A total of 4974 patients undergoing surgery for hip fractures in 2011 were identified. Of these patients, 4815 had complete information on discharge location and were included in the analysis.

Table 1 lists the results of the univariate analysis comparing demographics, preoperative comorbidities, and operative

Table 1. Univariate Analysis of Demographics, Preoperative Comorbidities, and Operative Factors for Hip Fracture Patients Discharged Home vs to Rehabilitation

	Home (n = 1268)		Rehabilitation (n = 3551)		
	n	%	n	%	*P*
Patient demographics					
Mean (SD) age,[a] y	72.8 (16.8)	—	82.0 (11.0)	—	<.001
Sex[a]					
Male	424	33.4	1029	29.0	.012
Female	843	66.5	2519	70.9	—
Preoperative comorbidities					
Diabetes mellitus[a]	193	15.2	635	17.9	.034
Smoker[a]	197	15.5	384	10.8	<.001
Alcohol use	23	1.8	40	1.1	.411
Dyspnea[a]	82	6.5	346	9.7	<.001
History of chronic obstructive pulmonary disease[a]	116	9.1	430	12.1	.004
History of congestive heart failure[a]	17	1.3	116	3.3	<.001
Hypertension requiring medication	707	55.8	2568	72.3	<.001
History of esophageal varices	1	0.0	2	0.1	.999
History of myocardial infarction[a]	4	0.3	25	0.7	.043
Renal failure	5	0.4	23	0.6	.392
Dialysis[a]	14	1.1	83	2.3	.007
Steroid use	56	4.4	195	5.5	.162
Weight loss	17	1.3	53	1.5	.785

[a]Statistically significant difference.

Continued on page E440

Table 1. Univariate Analysis of Demographics, Preoperative Comorbidities, and Operative Factors for Hip Fracture Patients Discharged Home vs to Rehabilitation (continued)

	Home (n = 1268)		Rehabilitation (n = 3551)		
	n	%	n	%	*P*
Preoperative comorbidities (continued)					
Bleeding disorder[a]	125	9.9	657	18.5	<.001
Transfusion[a]	57	4.5	252	7.1	.001
Central nervous system tumor	4	0.3	3	0.1	.219
Chemotherapy[a]	11	0.9	9	0.2	.031
Radiation therapy	5	0.4	6	0.2	.343
Previous percutaneous coronary intervention[a]	15	1.2	96	2.7	<.001
Previous percutaneous coronary stenting[a]	24	1.9	103	2.9	.001
History of angina	4	0.3	22	0.6	.088
History of peripheral vascular disease	9	0.7	38	1.1	.058
History of cerebrovascular accidents	34	2.7	81	2.3	.605
History of benign cerebrovascular accidents[a]	22	1.7	80	2.3	.021
Recent surgery	3	0.2	20	0.6	.070
Rest pain	2	0.2	2	0.1	.597
Impaired sensorium	10	0.8	35	1.0	.194
History of transient ischemic attacks[a]	22	1.7	77	2.2	.034
Hemiplegia	14	1.1	31	0.9	.999
Paraplegia	3	0.2	4	0.1	.686
Quadriplegia	1	0.1	0	0.0	.319
Ascites	4	0.3	11	0.3	.999
Hypertension[a]	707	55.8	2568	72.3	<.001
Cancer[a]	69	5.4	103	2.9	<.001
Operative factors					
Functional status					
Independent	897	70.7	2468	69.5	.445
Dependent	351	27.7	1023	28.8	—
DNR (do not resuscitate) status[a]	97	7.6	153	4.3	.010
Ventilator support	2	0.2	4	0.1	.657
CPT (*Current Procedural Terminology*) code					
27125[a]	291	22.9	658	18.5	<.001
27235	123	9.7	194	5.5	—
27236	320	25.2	1064	30.0	—
27244	228	18.0	568	16.0	—
27245	306	24.1	1067	30.0	—
General anesthesia[a]	812	64.0	2569	72.3	<.001
Wound class					
Clean	1249	98.5	3508	98.8	.350
Clean/contaminated	12	0.9	35	1.0	—
Contaminated	4	0.3	5	0.1	—
Dirty/infected	3	0.2	3	0.1	—
Wound infection	84	6.6	283	8.0	.124
ASA (American Society of Anesthesiologists) class[a]					
1	72	5.7	15	0.4	<.001
2	374	29.5	572	16.2	<.001
3	655	51.7	2306	64.9	<.001
4	164	12.9	650	18.3	<.001
5	1	0.1	4	0.1	<.001
Operative time >90 min[a]	339	26.7	772	21.7	<.001

[a]Statistically significant difference.

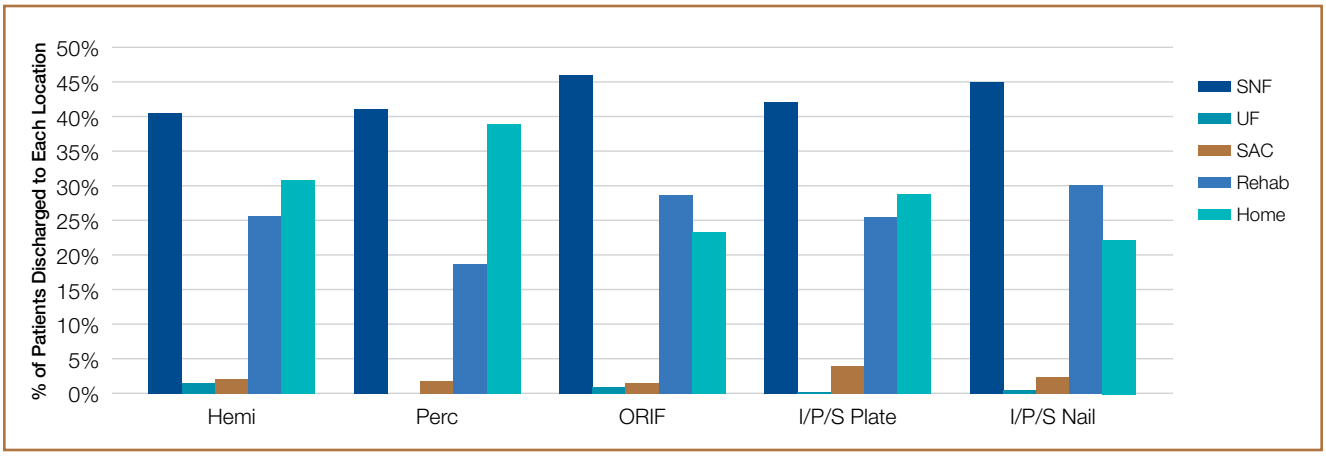

Figure. Distribution of discharge locations based on *CPT* (*Current Procedural Terminology*) code. Abbreviations: hemi, hemiarthoplasty; I/P/S, intertrochanteric/peritrochanteric/subtrochanteric; ORIF, open reduction and internal fixation of femoral neck fracture; perc, percutaneous fixation of femoral neck fracture; rehab, dedicated rehabilitation center; SAC, separate acute-care facility; SNF, skilled nursing facility; UF, unskilled facility (not patient's previous home).

factors between the home and rehabilitation groups. Both age ($P < .001$) and sex ($P = .012$) were significantly different between groups; the rehabilitation group was older by about 10 years and included significantly more females. In addition to demographic factors, 16 preoperative comorbidities, and 5 surgical factors were significantly associated with discharge to rehabilitation.

Surgery type significantly affected discharge to rehabilitation (**Figure**). Patients who were undergoing open plating of a femoral neck fracture or intramedullary nailing of an intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture constituted 30% of all patients discharged to rehabilitation centers. In contrast, patients undergoing percutaneous skeletal fixation of a proximal femoral fracture constituted only 5.5% of all patients discharged to rehabilitation. Based on surgery type, we broke down discharge location further, into categories of skilled nursing facility, unskilled facility (not patient's previous home), separate acute-care facility, dedicated rehabilitation center, and home. Of all 4815 patients combined, 2102 (43.6%) were discharged to a skilled nursing facility, 31 (0.6%) to an unskilled facility (not home), 106 (2.2%) to separate acute care, 1312 (27.2%) to a dedicated rehabilitation center, and 950 (19.7%) home.

Table 2 lists the significant results from the multivariate logistical analysis comparing discharge to a rehabilitation center and discharge home after controlling for the significant risk factors (Table 1). Current diabetes, history of dyspnea, previous myocardial infarction, history of ischemic attacks, current bleeding disorder, transfusion during hospitalization, previous percutaneous cardiac stenting, chemotherapy, past cerebrovascular accident, presence of cancer, surgery type based on CPT code, history of chronic obstructive pulmonary disease or congestive heart failure, current smoking status, and operative time longer than 90 minutes were not significantly correlated with discharge to rehabilitation in the multivariate analysis. All significant factors were associated with higher odds of discharge to rehabilitation except for DNR status. DNR patients were 2.04 times more likely (95% CI, 1.49-2.78; $P < .001$) to be discharged home than to rehabilitation centers.

Applying these adjusted odds ratios, we see that an elderly

Table 2. **Odds of Discharge to Rehabilitation Center vs Home**

Patient Factor	Adjusted Odds Ratio	95% CI	*P*
Age >65 years	3.79	2.67–5.37	<.001
Female sex	1.35	1.05–1.76	.022
Dialysis dependence	3.49	1.17–10.45	.025
Previous percutaneous coronary intervention	1.85	1.03–3.34	.041
Hypertension requiring medication	1.31	1.01–1.70	.039
General anesthesia	1.74	1.34–2.25	<.001
ASA (American Society of Anesthesiologists) class >2	1.98	1.48–2.64	<.001
DNR (do not resuscitate) status	0.49	0.36–0.67	<.001

Abbreviation: CI, confidence interval.

woman (age, >65 years) who underwent general anesthesia with an ASA class higher than 2 was 17.63 times more likely than a patient without these risk factors to be discharged to rehabilitation. If this patient were also dialysis-dependent, she would be 61.52 times more likely than a similar patient without dialysis needs to be discharged to rehabilitation.

Even when controlling for all significant and nonsignificant variables in multivariate logistical analysis, age over 65 years ($\beta = 1.05$; $P < .001$), female sex ($\beta = 1.76$; $P = .004$), dialysis dependence ($\beta = 12.98$; $P = .036$), hypertension requiring medication ($\beta = 1.53$; $P = .032$), and ASA class higher than 2 ($\beta = 1.98$; $P = .001$) were found to be significant risk factors for discharge to rehabilitation.

Discussion

This study was the first to investigate the issue of which patient risk factors allow the practicing orthopedist to identify patients who require rehabilitation after hip fracture surgery. Through our multivariate analysis, which controlled for demographics, comorbidities, and operative factors, we found that older age, female sex, history of percutaneous coronary intervention, dialysis dependence, general anesthesia, and ASA class higher than 2 significantly increased the odds of discharge to a rehabilitation center versus home.

Using our study's results, we can create a risk stratification model for patients and thereby a means of targeting patients who need rehabilitation and starting the process of finding a rehabilitation bed early in the postoperative course. Our study's variables are easily measured metrics that may be collected in any hospital setting. Especially for hip fracture patients, early planning and discharge to the appropriate rehabilitation center are important in decreasing LOS and associated hospitalization costs. According to one report,[3] about 85% of all hip fracture costs are directly related to LOS, given the unnecessarily long rehabilitation periods in hospitals. Hollingworth and colleagues[2] compared costs for patients who remained in the hospital with costs for those discharged with rehabilitation services. Overall costs were significantly lower for patients discharged home with rehabilitation. The authors concluded that 40% of hip fracture patients may be suitable for early discharge.[2] In an analysis of Medicare payments for hip fracture treatment, hospital costs including LOS accounted for 60% of all payments.[12] The results of these 2 studies suggest that the overall driver of hip fracture costs is prolonged LOS and that, if patients are discharged to rehabilitation, then overall costs may be lowered through a direct reduction in hospital LOS. Given that hip fractures account for almost 350,000 hospital admissions in the United States each year, and using our institution's average hospital charge per day ($4500), about $1.6 billion may be saved if each patient's LOS decreased by 1 day.[13] Although multiple factors affect LOS, discharge planning is under orthopedists' direct control. Therefore, early identification of patients who will require rehabilitation may help reduce LOS-associated costs in our health care system.

The patient variables that were significantly associated with discharge to rehabilitation are also associated with increased morbidity and mortality in hip fracture patients, according to the literature,[14-20] which provides some external validation of using these risk factors as predictors for rehabilitation. A patient with one of these risk factors may require rehabilitation, given that rehabilitation services are specifically linked to lower morbidity and mortality rates among hip fracture patients. For example, patients with dialysis needs were 3.49 times more likely to be discharged to a rehabilitation center in our study. In a 2000 study by Coco and Rush,[16] hip fracture patients on dialysis had a 1-year mortality rate 2.5 times higher than that of patients who were not dialysis-dependent. In 2010, Cameron and colleagues[17] found that cardiovascular disease was associated with a 2.68 times higher risk of mortality in hip fracture patients. Similarly in our study, both hypertension and history of percutaneous coronary intervention were associated with discharge to rehabilitation. We found higher odds of discharge to rehabilitation with higher ASA classes, which mirror results from a study by Michel and colleagues,[15] who found that higher (vs lower) preoperative ASA classes were associated with higher 1-year mortality in hip fracture patients. Interestingly, DNR status was associated with higher odds of discharge home, which may reflect patients' desires to forgo noninvasive or lifesaving procedures that may be performed at rehabilitation facilities. Although general anesthesia predisposed patients to discharge to a rehabilitation center, multiple studies have found no association between anesthesia type and postoperative mortality rates for hip fracture patients.[18,19] Last, Marcantonio and colleagues[20] found delirium specifically had a higher odds ratio for discharge, but our univariate analysis did not find a significant association between impaired sensorium and discharge location. Given the correlation of our risk factors with increased morbidity and mortality in the literature, our study's results provide the initial groundwork for creating a risk calculator that orthopedists can use to predict discharge to rehabilitation.

Our study had some limitations. Although we analyzed a large number of demographics, preoperative comorbidities, and surgical factors, our univariate analysis was limited to information in the ACS-NSQIP database. We did not incorporate other clinically relevant factors (eg, social factors, including patients' support networks) that may influence discharge decisions. Furthermore, ACS-NSQIP records patient data only up to 30 days after surgery. Discharge information for the time after that was missing for a subset of hip fracture patients, and these patients had to be excluded, potentially skewing our data. ACS-NSQIP also does not collect cost data for patients based on hospitalization or LOS, so we could not determine whether patients discharged to rehabilitation incurred higher costs because of longer hospitalizations.

Nevertheless, our study identified significant patient and operative variables that are associated with discharge to a rehabilitation center. By identifying hip fracture patients with these risk factors early and mobilizing the appropriate resources, practicing orthopedists should be better equipped to help facilitate the discharge of patients to the appropriate location after surgery. Validation of these risk factors should be prospectively

determined with an analysis of LOS and cost implications. Use of a risk calculator may in fact result in decreased LOS and hospital-related costs. Furthermore, using these risk factors in a prospective patient cohort would help validate their use and determine whether there is clinical correlation. The orthopedists in our institution are becoming more aware of these risk factors, but validation is necessary.

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