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Factors Associated With Inability to Bear Weight Following Hip Fracture Surgery: An Analysis of the ACS-NSQIP Hip Fracture Procedure Targeted Database

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Abstract

Introduction: While the benefits of early mobility for prevention of complications such as pneumonia, thromboembolic events, and improved mortality have been well studied in postsurgical patients, it is unclear which patients may struggle to achieve full weight-bearing on the first postoperative day. **Materials and Methods:** The 2016 American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) Targeted Hip Fracture Database was queried regarding the ability to achieve weight-bearing on first postoperative day for older adults. Cases that occurred secondary to malignancy were excluded or for which weight-bearing was unachievable on the first postoperative day due to medical reasons were excluded. **Results:** A total of 6404 patients met inclusion and exclusion criteria for the study, with 1640 (25.6%) patients unable to bear weight on the first postoperative day. Following adjusted analysis, nonmodifiable patient factors such as dependent (partial or total) functional health status, dyspnea with moderate exertion (odds ratio [OR]: 1.31 [95% confidence interval, CI: 1.04-1.65]), ventilator dependency, and preoperative dementia on presentation to hospital were associated with lack of achievement of weight-bearing on the first postoperative day. Modifiable patient factors such as presence of systemic inflammatory response syndrome (OR: 1.35 [95% CI: 1.11-1.64]), delirium, and low preoperative hematocrit and modifiable system factors including delayed time to surgery, total postoperative time >90 minutes, and transfer from an outside emergency department were also associated with inability to achieve weight-bearing on the first postoperative day. **Discussion:** Medical teams can utilize the results from this study to better identify patients preoperatively who may be at risk of not achieving early mobilization and proactively employ implement strategies to encourage mobility as soon as possible for hip fracture patients.

Keywords

weight bearing, WBAT, mobility, hip fracture, surgery, NSQIP

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Introduction

Hip fractures are one of the most common and debilitating injuries that affect the elderly population worldwide, with a global incidence estimated to be around 1.6 million fractures annually.[1,2] Despite advances in the realm of orthopedic trauma, hip fractures continue to be associated with significant morbidity[3,4] and mortality.[5,6] Furthermore, hip fractures in the elderly also pose a significant economic burden to the health-care system owing to the need for a multidisciplinary approach, involving surgeons, geriatric physicians, physiatrists, and caregivers, to ensure optimum functional outcome is achieved following surgery. Recent literature has reported that more than US$10 billion is spent annually in care associated with hip fractures.[7] However, despite surgery for treatment of hip fractures and physical therapy, fewer than half of patients recover their prefracture mobility.[8]

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Although innovations of biomechanically superior surgical fixation techniques over the course of several decades have drastically improved the outcome of hip fractures, rehabilitation still remains a crucial turning point in ensuring a good functional outcome. Early postoperative mobilization, such as weight-bearing within 48 hours after hip fracture surgery, has been shown to have a positive impact on regaining functional mobility,[9] reduce the length of in-patient stay, increase the probability of discharge to home, and lower the risk of mortality.[10,11] In addition, weight-bearing may also help build confidence, functional ability, and strength for quicker independent ambulation. Despite international guidelines[12,13] and evidence[14] encouraging the adoption of weight-bearing as early as the first postoperative day, some elderly patients historically have been told to limit weight-bearing activities postoperatively.[15] Furthermore, a recent survey-based study found that though there was a consensus with regard to early weight-bearing being part of best practice, there were some cases in which "slippage" of this adherence would take place primarily due to certain patient characteristics such as types of fracture patterns or poor bone quality and surgeon factors, including concerns regarding failing of the implant and a lack of certainty with regard to the importance of weight-bearing on postoperative recovery.[16]

Current evidence is very limited with regard to which patient characteristics may influence a patient's inability to bear weight following surgery. As we move toward an era of evidence-based medicine, identification of patients who may have difficulty in achieving weight-bearing on the first postoperative day may support caregivers' ability to provide individualized, system-supported strategies to promote early mobility. We sought to utilize a national, multicenter hip fracture database/registry in order to answer our research question: What are the incidence and risk factors associated with an inability to bear weight as tolerated in older adults following hip fracture surgery?

Materials and Methods

Database

In 2016, the ACS-NSQIP released a Targeted Procedure Hip Fracture file that consisted of relevant variables for hip fracture cases treated with open reduction and internal fixation (ORIF; CPT-27236, CPT-27244, CPT-27245) collected from a total of 117 clinical sites.[17] Using unique case-specific ID numbers, the database allows researchers to merge the current file with the larger ACS-NSQIP file to include further variables.[17] The queried data set was filtered to remove fracture repairs for malignancies. Only patients 65 years of age or older were included to reflect the older adult population. In addition, patients who were unable to achieve weight-bearing on the first postoperative day (POD) due to a preoperative bedridden status were excluded to ensure that a relevant otherwise mobile older adult population was included in the study.

Rather than relying on just physician orders of prescribed "weight-bearing as tolerated (WBAT)" orders, the NSQIP data set makes use of both physician orders and documented patient's performance to identify individuals who were successfully able to weight-bear on the first postoperative day. This approach prevents the misclassification of those patients who may have had a documented physician order of "WBAT" status but were actually unable to successfully bear weight. Trained NSQIP clinical reviewers identify the weight-bearing status on the first postoperative day using therapy/nursing/physician notes and orders before the conclusion of the first postoperative day. The variable is classified as "yes" if the following scenarios are met: (1) the patient stood on the operative leg or walked on it within the first calendar date after surgery or (2) the patient was mobile with therapy and assistive device such as walker bearing weight as tolerated on postoperative day 1. The variable was classified as "no" if: (1) there was no clear evidence of WBAT, (2) the patient refused to stand or walk with therapy, or (3) partial weight-bearing/non-weight-bearing/toe-touching weight-bearing physical therapy orders were given, a bed-to-chair order was noted, or an order was present but no documentation that the patient activity occurred.

A total of 6404 patients were included in the final cohort and divided into 2 groups for clinical comparison—(1) those who were able to weight-bear on POD 1 (as identified using criteria noted above) and (2) those who were unable to achieve weight-bear on POD 1 as identified by NSQIP.

To ascertain factors associated with an inability to bear weight on POD 1, a number of preoperative variables were considered: (1) patient demographics (age, gender, race/ethnicity), (2) comorbidities (as defined by NSQIP database), (3) body mass index (kg/m^2), (4) functional health status—independent (individual does not require assistance from another person for activities of daily living), partially dependent (requires some assistance), and dependent (requires total assistance), (5) hip-specific factors (preoperative delirium, preoperative dementia, preoperative bone fracture protection medication, preoperative pressure sore), (6) preoperative use of mobility aid, (7) medical comanagement during hospital stay, (8) implementation of a standardized hip fracture care program, (9) type/location of fracture, (10) type of anesthesia and American Society of Anesthesiolgists (ASA) class, (11) transfer status (home, acute care hospital/inpatient, nursing home/chronic care facility, outside emergency department [ED], and unknown), (12) quarter of admission, and (13) time from admission to operation (within 1 day or more than 1 day) were assessed. Operative and lab-specific variables that were also part of the analysis included total operative time, preoperative hypoalbuminemia ($<$3.5 g/dL), preoperative hyponatremia ($<$135 mEq/L), and hematocrit levels ($<$36 or $\geq$36).

Unadjusted analysis to identify significant associations between clinical characteristics and no weight-bearing on POD 1 was performed using Pearson χ^2 test. Since a significant number of patients had missing data with regard to preoperative lab values, the "missing indicator" method of analysis was used to assess presence of any associations. Roughly summarizing, the "missing indicator" method uses univariate logistic regression while adjusting for the presence of missing data.[18] This specific method has been employed in database studies before owing to the fact that missing data in NSQIP do not occur at random.[19]

All variables with a *P* value <.1 in unadjusted analysis were then entered into a multivariate logistic regression model while adjusting for each other. All variables with a *P* value <.05 from the multivariate regression model were identified as independent risk factors significantly associated with an inability to bear weight following ORIF for hip fracture. Statistical analysis was performed using SPSS version 22 (IBM, Armonk, New York, 2016).

Results

Baseline Clinical Characteristics

A descriptive analysis of baseline demographics and clinical characteristics is shown in Table 1. The majority of patients were female (n = 4595; 71.8%) and in the age-group 80 to 89 years (n = 2869; 44.8%). A total of 1640 (25.6%) patients did not achieve weight-bearing on the first POD. Twenty-nine percent of patients used a mobility aid preoperatively (N = 1843; 28.8%). The most common type of fracture was intertrochanteric (n = 3460; 54.0%) followed by displaced femoral neck fractures (n = 1873; n = 29.2%). Univariate analysis showed that the weight-bearing versus no weight-bearing groups were significantly different with regard to several preoperative and postoperative characteristics (Tables 2 and 3).

Independent Risk Factors Associated With "No Weight-Bearing on POD 1"

Following adjusted analysis, significant risk factors associated with inability to bear weight as tolerated on first postoperative day, in descending order of effect, were being ventilator dependent preoperatively (odds ratio [OR]: 8.15 [95% confidence interval, CI: 1.55-43.0]; *P* = .013), totally dependent functional health status prior to surgery (OR: 1.99 [95% CI: 1.38-2.90; *P* < .001], subtrochanteric versus undisplaced femoral neck fracture (OR: 1.99 [95% CI: 1.46-2.70]; *P* < .001), absence of preoperative mobility aid use (OR: 1.64 [95% CI: 1.22-2.21]; *P* = .001), a total operative time > 90 minutes (OR: 1.50 [95% CI: 1.26-1.79]; *P* < .001), partially dependent functional health status (OR: 1.42 [95% CI: 1.21-1.66]; *P* < .001), admission in the first quarter of the year (OR: 1.39 [95% CI: 1.19-1.64]; *P* < .001), having an intertrochanteric versus undisplaced femoral neck fracture (OR: 1.38 [95% CI: 1.11-1.73]; *P* = .004), preoperative dementia (OR: 1.36 [95% CI: 1.18-1.58]; *P* < .001), having a prior history of systemic inflammatory response syndrome (OR: 1.35 [95% CI: 1.11-1.64]; *P* = .003), implementation of a standardized hip fracture care program (OR: 1.31 [95% CI: 1.16-1.47]; *P* < .001), presence of preoperative dyspnea with moderate exertion (OR: 1.31 [95% CI: 1.04-1.65]; *P* = .022), preoperative delirium (OR: 1.30 [95% CI: 1.08-1.57]; *P* = .005), a transfer from an outside ED (OR: 1.24 [95% CI: 1.01-1.52]; *P* = .040), preoperative hematocrit <36 (OR: 1.23 [95% CI: 1.08-1.39]; *P* = .002), and a delayed time to surgery >1 day (OR: 1.16 [95% CI: 1.003-1.33]; *P* = .045; Table 4).

Discussion

Despite early weight-bearing following hip fracture surgery being a widely accepted standard of care globally, the current study's findings show that nearly 25% of patients are unable to bear weight on the first postoperative day. It appears that there are a number of important patient (preoperative cognitive impairment and higher comorbidity burden), provider (admission during first quarter of the year, delayed time to surgery >1 day, operative time >90 minutes), and fracture characteristics (intertrochanteric/subtrochanteric vs undisplaced femoral neck fracture) that are associated with inability to bear weight on the first postoperative day.

Baseline impairments in functional status,[20] stability, and cognitive function are associated with a higher risk of falls, increased frailty, loss of independence, and poor recovery following hip fractures.[20,21] In a patient with already vulnerable physical function, hip trauma and the physical manipulation of muscles during surgery may impair postoperative ability to ambulate. Osnes et al reported that 43% of patients lost their original mobility following a hip fracture,[22] and mobility remained a long-term challenge with nearly 20% of patients staying bedridden 1 year after surgery. Hip fracture patients are also at high risk for pressure sores, thromboembolism, and pneumonia due to prolonged immobilization.[23,24] As a result of poor outcomes for immobilized patients, many enhanced recovery after surgery (ERAS) protocols and hospital initiatives have focused on mobilizing patients safely, even in the sickest such as ventilated intensive care unit patients and transplant patients.[25,26] Mobilizing hip fracture patients with just a few steps on the first day after surgery can significantly improve patients' confidence, endurance, and outcomes.[27,28] In the current study, the patients who were most at risk of inability to achieve weight-bearing on the first POD were ventilator-dependent patients (OR: 8.15) and patients who were categorized as totally dependent for functional health status (OR: 1.99). While intuitively it makes sense that these patients may struggle to achieve weight-bearing on POD 1 and beyond, this should not preclude an enhanced recovery pathway to push for early weight-bearing and mobilization. Instead, developing strategies to mobilize even the most frail hip fracture patients could significantly impact outcomes for hip fracture patients.

Recent literature has identified numerous barriers to early mobilization after hip fracture surgery.[20] Limited mobility of hospital patients is common and often results from behavioral and cultural challenges for patients, families, and caregivers.[26,29,30] In addition, hospital initiatives for patient safety and quality have recently prioritized fall prevention in the hospital, which has resulted in a resurgence of physical restraints and decreased overall mobility in patients.[31-33] Uniform

Table 1. Baseline Clinical Characteristics of the Study Population.

Baseline Demographics	Number	Percentage
Age (years)		
65-79	1969	30.7%
80-89	2869	44.8%
≥90	1566	24.5%
Gender		
Male	1809	28.2%
Female	4595	71.8%
Body mass index/BMI (kg/m^2)		
<25.0	3613	56.4%
25.0-29.0	1803	28.2%
30.0-35.0	692	10.8%
>35.0	296	4.6%
Race		
White	4930	77.0%
Unknown/not reported	1193	18.6%
Black or African American	151	2.4%
Asian	120	1.9%
American Indian or Alaska Native	6	0.1%
Native Hawaiian or Pacific Islander	4	0.1%
Comorbidities	-	-
Hypertension (HTN) requiring medication	4463	69.7%
Function health status—partially dependent	1171	18.3%
Bleeding disorders	1149	17.9%
Non-insulin-dependent diabetes mellitus (NIDDM)	704	11.0%
History of severe COPD	685	10.7%
Prior history of SIRS	575	9.0%
Smoker within the past year	549	8.6%
Insulin-dependent diabetes mellitus (IDDM)	477	7.4%
Dyspnea at moderate exertion	414	6.5%
Chronic steroid use	346	5.4%
Transfusion of at least one unit of packed RBCs within 72 hours	296	4.6%
Congestive heart failure (CHF) in 30 days before surgery	243	3.8%
Open wound/wound infection	229	3.6%
Function health status—totally dependent	138	2.2%
Preoperative dialysis	103	1.6%
Disseminated cancer	92	1.4%
>10% weight loss in the last 6 months	92	1.4%
Dyspnea at rest	56	0.9%
Prior history of sepsis	29	0.5%
Acute renal failure (ARF)	26	0.4%
Ascites	11	0.2%
Ventilator dependent	8	0.1%
Prior history of septic shock	3	0.0%
Other hip-specific factors		
Preoperative dementia	1843	28.8%
Prefracture bone protection medication use	1843	28.8%
Preoperative delirium	722	11.3%
Preoperative Pressure Sore	216	3.4%
Use of mobility aid		
Yes	3486	54.4%
No	2703	42.2%
Unknown	215	3.4%
Medical comanagement during stay		
Complete	5091	79.5%
Partial	775	12.1%
None	538	8.4%
Standardized Hip Fracture Care Program		
Yes	3204	50.0%
No	3200	50.0%
Weight-bearing on postoperative day 1		
Yes	5280	74.2%
No	1838	25.8%
Type/location of fracture		
Femoral neck Fx (subcapital, Garden type 1 and 2)—undisplaced	558	8.7%
Femoral neck Fx (subcapital, Garden type 3 and 4)—displaced	1873	29.2%
Intertrochanteric	3460	54.0%
Subtrochanteric	356	5.6%
Other/cannot be determined	157	2.5%
Type of anesthesia		
General (GA)	5202	73.1%
Other (MAC/regional/epidural/spinal)	1916	26.9%
ASA class		
I	23	0.4%
II	1022	16.0%
III	4122	64.4%
IV	1231	19.2%
V	6	0.1%
Emergency case		
Yes	1834	28.6%
No	4570	71.4%
Transferred from		
Home	4902	76.5%
Nursing home/chronic care facility	637	9.9%
Outside ED	543	8.5%
Acute care hospital (inpatient)	242	3.8%
Other	66	1.0%
Unknown	14	0.2%
Quarter of admission		
January to March	1632	25.5%
April to June	1508	23.5%
July to September	1527	23.8%
October to December	1737	27.1%
Time from admission to operation (days)		
≤1 day	4971	77.6%
>1 day	1433	22.4%
Total operative time (minutes)		
0-45	2332	36.4%
46-90	2947	46.0%
>90	1125	17.6%
Preoperative hypoalbuminemia (<3.5g/dL)		
No	2175	34.0%
Yes	1801	28.1%
Missing	2428	37.9%
Preoperative hematocrit (Hct)		
Hct > 36	2812	43.9%
Hct < 36	3576	55.8%
Missing	16	0.2%
Preoperative hyponatremia (Na < 135)		
No	5325	83.2%
Yes	1054	16.5%
Missing	25	0.4%

Abbreviations: ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; ED, emergency department; Fx, fracture; MAC, monitored anesthesia care; RBC, red blood cells; SIRS, systemic inflammatory response syndrome.

Table 2. Univariate Analysis of Factors Using χ^2 Analysis.[a]

Risk Factors

Variable	No Weight-Bearing	Weight-Bearing	*P* Value
Age (years)			**.029**
65-79	474 (28.9%)	1495 (31.4%)	
80-89	728 (44.4%)	2141 (44.9%)	
≥90	438 (26.7%)	1128 (23.7%)	
Gender			.272
Male	446 (27.2%)	1363 (28.6%)	
Female	1194 (72.8%)	3401 (71.4%)	
Body mass index/BMI (kg/m^2)			.109
<25.0	937 (57.1%)	2676 (56.2%)	
25.0-29.0	452 (27.6%)	1351 (28.4%)	
30.0-35.0	161 (9.8%)	531 (11.1%)	
>35.0	90 (5.5%)	206 (4.3%)	
Race			.113
White	1234 (75.2%)	3696 (77.6%)	
Black or African American	40 (2.4%)	111 (2.3%)	
Asian	26 (1.6%)	94 (2.0%)	
American Indian or Alaska Native	0 (0%)	6 (0.1%)	
Native Hawaiian or Pacific Islander	1 (0.1%)	3 (0.1%)	
Unknown/Not Reported	339 (20.7%)	854 (17.9%)	
Comorbidities			
Diabetes			.433
- IDDM	134 (8.2%)	343 (7.2%)	
- NIDDM	178 (10.9%)	343 (7.2%)	
- No	1328 (81.0%)	3895 (81.8%)	
Smoker within past year	142 (8.7%)	407 (8.5%)	.886
Dyspnea			**.002**
- At rest	14 (0.9%)	42 (0.9%)	
- Moderate exertion	136 (8.3%)	278 (5.8%)	
- No	1490 (90.9%)	4444 (93.3%)	
Functional health status			**<.001**
- Totally dependent	63 (3.8%)	75 (1.6%)	
- Partially dependent	412 (25.1%)	759 (15.9%)	
- Unknown	19 (1.2%)	28 (0.6%)	
- Independent	1146 (69.9%)	3902 (81.9%)	
Ventilator dependent	6 (0.4%)	2 (0.0%)	**.001**
History of severe COPD	204 (12.4%)	481 (10.1%)	**.008**
Ascites	6 (0.4%)	5 (0.1%)	**.028**
Congestive heart failure (CHF) within the last 30 days	71 (4.3%)	172 (3.6%)	.189
Hypertension (HTN) requiring medication	1150 (70.1%)	3313 (69.5%)	.660
Preoperative dialysis	37 (2.3%)	66 (1.4%)	**.016**
Disseminated cancer	18 (1.1%)	74 (1.6%)	.181
Chronic steroid use	79 (4.8%)	267 (5.6%)	.224
Open wound/wound infection	80 (4.9%)	149 (3.1%)	**.001**
Bleeding disorders	301 (18.4%)	848 (17.8%)	.614
Transfusion of at least one unit of packed RBCs <72 hours	108 (6.6%)	188 (3.9%)	**<.001**
Systemic sepsis			**<.001**
- Prior history of sepsis	7 (0.4%)	22 (0.5%)	
- Prior history of septic shock	2 (0.1%)	1 (0.0%)	
- Prior history of SIRS	186 (11.3%)	389 (8.2%)	
>10% weight loss in last 6 months	29 (1.8%)	63 (1.3%)	.191
Acute renal failure (ARF)	11 (0.7%)	15 (0.3%)	**.051**
Other hip-specific factors			
Preoperative dementia	620 (37.8%)	1223 (25.7%)	**<.001**
Preoperative delirium	258 (15.7%)	464 (9.7%)	**<.001**
Prefracture bone protection medication use	486 (29.6%)	1357 (28.5%)	.375
Preoperative Pressure Sore	76 (4.6%)	140 (2.9%)	**.001**
Preoperative use of mobility aid			**<.001**
Yes	1004 (61.2%)	2482 (52.1%)	
Unknown	88 (5.4%)	127 (2.7%)	
No	548 (33.4%)	2155 (45.2%)	
Medical comanagement during stay			**.016**
Complete	1294 (78.9%)	3797 (79.7%)	
Partial	226 (13.8%)	549 (11.5%)	
None	120 (7.3%)	418 (8.8%)	
Standardized Hip Fracture Care Program			**<.001**
Yes	892 (54.4%)	2312 (48.5%)	
No	748 (45.6%)	2452 (51.5%)	
Type/location of fracture			**<.001**
Femoral neck Fx (subcapital, Garden type 1 and 2)—undisplaced	123 (7.5%)	435 (9.1%)	
Femoral neck Fx (subcapital, Garden type 3 and 4)—displaced	375 (22.9%)	1498 (31.4%)	
Intertrochanteric	962 (58.7%)	2498 (52.4%)	
Subtrochanteric	132 (8.0%)	224 (4.7%)	
Other/cannot be determined	48 (2.9%)	109 (2.3%)	
Type of anesthesia			.116
General (GA)	1211 (73.8%)	3422 (71.8%)	
Other (MAC/regional/epidural/spinal)	429 (26.2%)	1342 (28.2%)	
ASA class			**<.001**
≤II	200 (12.2%)	845 (17.7%)	
>II	1440 (87.8%)	3919 (82.3%)	
Emergency case			.332
Yes	485 (29.6%)	1349 (28.3%)	
No	1155 (70.4%)	3415 (71.7%)	
Transferred from			**<.001**
Home	1158 (70.6%)	3744 (78.6%)	
Acute care hospital (inpatient)	70 (4.3%)	172 (3.6%)	
Nursing home/chronic care facility	224 (13.7%)	413 (8.7%)	
Outside ED	161 (9.8%)	382 (8.0%)	
Other	23 (1.4%)	43 (0.9%)	
Unknown	4 (0.2%)	10 (0.2%)	
Quarter of admission			**<.001**
January to March	485 (29.6%)	1147 (24.1%)	
April to June	362 (22.1%)	1146 (24.1%)	

(continued)

Table 2. (continued)

Risk Factors			
Variable	No Weight-Bearing	Weight-Bearing	*P* Value
July to September	398 (24.3%)	1129 (23.7%)	
October to December	395 (24.1%)	1342 (28.2%)	
Time from admission to operation (days)			**<.001**
≤1 day	1206 (73.5%)	3765 (79.0%)	
>1 day	434 (26.5%)	999 (21.0%)	
Total operative time (minutes)			**<.001**
0-45	598 (35.9%)	1744 (36.6%)	
46-90	712 (43.4%)	2235 (46.9%)	
>90	340 (20.7%)	785 (16.5%)	

Abbreviations: ED, emergency department; Fx, fracture; IDDM, insulin-dependent diabetes mellitus; NIDDM; non-insulin-dependent diabetes mellitus; RBC, red blood cells; SIRS, systemic inflammatory response syndrome.
[a]All variables with a *P* value <0.1 were included into a multivariate logistic regression model and adjusted for each other. Bold text indicates variables that were included in the multivariate model.

Table 3. Univariate Analysis of Lab Values Using Logistic Regression Analysis While Adjusting for the Presence of Missing Variables.[a]

Variable	Odds Ratio [95% CI]	*P* Value
Hypoalbuminemia		
No	Ref	-
Yes	1.20 [1.05-1.39]	.010
Missing	0.93 [0.82-1.07]	.324
Hyponatremia		
No	Ref	-
Yes	0.96 [0.82-1.11]	.554
Missing	1.36 [0.59-3.16]	.476
Hematocrit (Hct)		
Hct >36	Ref	-
Hct <36	1.47 [1.31-1.65]	<.001
Missing	1.21 [0.39-3.77]	.741

Abbreviation: CI, confidence interval.
[a]All variables with a *P* value <1.0 were included into a multivariate logistic regression model and adjusted for each other. Bold text indicates variables that were included in the multivariate model.

implementation of certain interventions such as dissemination of knowledge regarding benefits of early mobility among patients, building of confidence in staff and patients, incorporation of families in shared decision-making, and availability of mobility equipment have the potential of increasing the mobility of hospitalized patients. The current study helps identify patients who may be most at risk of immobility after hip fracture surgery, to better target mobility strategies and help care teams overcome barriers to early mobilization for the highest risk patients.

While many factors identified in the current study are non-modifiable characteristics of patients, there are several modifiable factors such as anemia, delirium, delays to surgery, and prolonged surgical time that were identified that if addressed may improve mobility. A significant number of older adults had a low baseline hematocrit <36, which was associated with inability to bear weight. Many elderly patients may have age-related anemia at baseline that may be exacerbated by fracture hematoma or bleeding due to other injuries at the time of a fall.[34,35] Anemia can lead to weakness, which may affect a patient's ability to safely ambulate. Despite extensive literature showing preoperative cognitive impairment, in the form of delirium, as well as dementia to significantly impact postoperative recovery,[36-38] a recent study appears to suggest that existing disorientation should not be a major red flag in preventing mobility.[39] In the context of these findings, it becomes imperative to stress the importance of perioperative medical optimization in these patients particularly of the need for adoption of multicomponent delirium prevention and/or care pathways involving early mobilization/rehabilitation, hydration, nutrition, and patient orientation.[40]

A delayed time to surgery was also associated with inability to achieve weight-bearing. While delays to surgery may be a reflection of the frailty of the patient and need for further medical optimization prior to surgical intervention, there is ample evidence to support early operative treatment within 48 hours of presentation[41,42] and timing of surgery is a modifiable factor. In addition, surgery time greater than 90 minutes was associated with inability to achieve WBAT status. While higher operative time may reflect the overall difficulty of a case, appropriate surgical team and staffing may help improve surgical time and indirectly improve mobility after surgery.

It is important to consider that the NSQIP database is unable to distinguish if the non-weight-bearing was due to an absence of an order or due to patient's inability to bear weight. Studies have shown that patients' restricted weight-bearing orders after surgery negatively impacts mobility for hip fracture patients.[28] Ruedi et al[43] and Lichtbau[44] reported that stable femoral neck fractures are able to tolerate immediate full weight-bearing, but certain fracture patterns such as subtrochanteric fractures, as seen in our study, are more complicated and surgeons may individualize weight-bearing orders according to the severity and/or complexity of the fracture.

Despite widespread consensus that older hip fracture patients should be WBAT after surgery, adoption of this concept into practice is lower than expected and the care gap between guidelines and actual practice is not well understood. An international survey found that WBAT status following ORIF after femoral neck fractures was ordered in only 40% of the patients.[45] Australian literature reported that WBAT was prescribed in 77% of hip fracture patients.[16] A recent survey of Canadian surgeons found that 10% of each provider's patients did not get immediate weight-bearing orders following surgery. The latter study went on to describe that there was a gap-in-care for patients related to immediate weight-bearing after hip fracture surgery. Despite standardized guidelines reporting the need for immediate weight-bearing, several factors impacted immediate weight-bearing after hip fracture surgery not occurring such as "orders not carried out by patient or staff despite being prescribed by surgeon," type of fracture, and fear fracture healing failure due to previous experiences.

Table 4. Significant Factors Associated With Not Achieving Weight-Bearing on First Postoperative Day Following Adjusted Analysis Using Multivariate Logistic Regression Analysis (area under the curve = 0.667 [95% CI: 0.65-0.68]).

Variable	Odds Ratio [95% CI]	*P* Value
Dyspnea		
At rest	0.75 [0.39-1.43]	.389
Moderate exertion	1.31 [1.04-1.65]	**.022**
No	Ref	-
Functional health status		
Totally dependent	1.99 [1.38-2.90]	**<.001**
Partially dependent	1.42 [1.21-1.66]	**<.001**
Unknown	1.69 [0.91-3.13]	.097
Independent	Ref	-
Ventilator dependent		
Yes	8.15 [1.55-43.0]	**.013**
No	Ref	-
Prior history of systemic sepsis		
Sepsis	0.69 [0.29-1.65]	.404
Septic shock	3.33 [0.28-39.13]	.340
SIRS	1.35 [1.11-1.64]	**.003**
None	Ref	-
Preoperative dementia		
Yes	1.36 [1.18-1.58]	**<.001**
No	Ref	-
Preoperative delirium		
Yes	1.30 [1.08-1.57]	**.005**
No	Ref	-
Preoperative mobility aid use		
Yes	Ref	-
Unknown	0.79 [0.69-0.90]	**<.001**
No	1.64 [1.22-2.21]	**.001**
Standardized hip fracture program		
Yes	1.31 [1.16-1.47]	**<.001**
No	Ref	-
Type/location of fracture		
Femoral neck Fx (subcapital, Garden Type 1 and 2)—undisplaced	Ref	-
Femoral neck Fx (subcapital, Garden Type 3 and 4)—displaced	0.80 [0.63-1.02]	.069
Intertrochanteric	1.38 [1.11-1.73]	**.004**
Subtrochanteric	1.99 [1.46-2.70]	<.001
Other/cannot be determined	1.50 [0.99-2.27]	.054
Quarter of admission		
January to March	1.39 [1.19-1.64]	**<.001**
April to June	1.05 [0.89-1.25]	.545
July to September	1.14 [0.97-1.35]	.122
October to December	Ref	-
Transferred from		
Home	Ref	-
Acute care hospital (inpatient)	0.99 [0.73-1.35]	.963
Nursing home/chronic care facility	1.13 [0.92 1.38]	.235
Outside ED	1.24 [1.01-1.52]	**.040**
Other	1.41 [0.83-2.41]	.208
Unknown	1.48 [0.45-4.89]	.523
Time from admission to operation (days)		
≤1 day	Ref	-
>1 day	1.16 [1.003-1.33]	**.045**
Total operative time (minutes)		
0-45	Ref	-
46-90	1.05 [0.92-1.21]	.439
>90	1.50 [1.26-1.79]	**<.001**
Hematocrit		
>36	Ref	-
<36	1.23 [1.08-1.39]	**.002**
Missing	1.16 [0.36-3.77]	.804

Abbreviations: CI, confidence interval; ED, emergency department; SIRS, systemic inflammatory response syndrome. Bold text indicates statistical significance.

An interesting finding of this study is that patients treated within a standardized hip fracture program were more likely to not achieve weight-bearing on postoperative day 1 compared to those not in a standard hip fracture program. While nearly 50% of the patients were treated in a hip fracture program, 28% of the patients in a standard hip fracture program were unable to weight-bear on the first postoperative day. There are many different protocols for standard hip fracture programs and goals of care may differ among programs. However, early mobility is often a focus for many of these programs and mobility protocols may vary significantly. Standard clinical practice guidelines related to weight-bearing and mobility after hip fracture remains limited, despite robust evidence that weight-bearing limitations and immobility can significantly impact outcomes after hip fracture. Although the American Academy of Orthopedic Surgeons has issued a clinical practice guideline for hip fracture, mobility and more specifically weight-bearing status have not been directly addressed. Future work should focus on mobility and weight-bearing metrics after hip fracture to provide more evidence-based clinical practice guidelines to address the care gap in guidelines for WBAT and actual clinical practice.

There are several limitations to the study. Firstly, the ACS-NSQIP Targeted Hip fracture database does not give details with regard to functional outcomes which may be useful in assessing the short-term impact of early weight-bearing. Secondly, the NSQIP only records the presence or absence of a hip fracture standardized program. With differences in the types of program being utilized by hospitals, there is a need for future databases to record more granular data with regard to specific components that were implemented. Thirdly, it does contain data with regard to the number and types of medications used before and after surgery as well as whether the patient was in the intensive care setting following the surgery which may significantly impact the ability to mobilize. Fourthly, the current NSQIP variable only records the presence of absence of a weight-bearing performance status. It would be interesting to note how often surgeons do not prescribe a WBAT order after surgery, and the frequency of patients who are reluctant to mobilize despite the presence of a WBAT physician order. In addition, incorporation of the time spent by physical therapists with patients on the first postoperative day may also shine some light on whether seasonal variation/staff workload plays an impact on early weight-bearing. Finally, the ACS-NSQIP Targeted Hip Fracture records data from only a few hospitals and the results may not be generalized to the national population.

Conclusion

The current study identifies a number of significant predictors associated with inability to achieve weight-bearing on the first postoperative day. In general, patients with significant functional and cognitive comorbidities undergoing surgery for intertrochanteric/subtrochanteric versus nondisplaced femoral neck fractures were less likely to weight-bear immediately after surgery. The current study helps identify patients who may be most at risk for immobility after hip fracture surgery, allow provider to launch better mobility strategies, and help care teams overcome barriers to early mobilization for hip fracture patients.

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