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 implementation strategies to encourage mobility as soon as possible for hip fracture patients.

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

Submitted July 31, 2018. Revised January 18, 2019. Accepted February 16, 2019.

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 morbidity³,⁴ 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, reduce the length of in-patient stay, increase the probability of discharge to home, and lower the risk of mortality. In addition, weight-bearing may also help build confidence, functional ability, and strength for quicker independent ambulation. Despite international guidelines and evidence 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. 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. 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. 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. 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/m²), (4) functional health status—individual (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 Anesthesiologists (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 hypotension (<135 mEq/L), and hematocrit levels (<36 or ≥36).

Unadjusted analysis to identify significant associations between clinical characteristics and no weight-bearing on POD 1 was performed using Pearson χ² 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. Oses 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.29 Limited mobility of hospital patients is common and often results from behavioral and cultural challenges for patients, families, and caregivers.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/m²)** | | |
| <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 | 4663 | 69.7% |
| Function health status—partially dependent | 1171 | 18.3% |
| **Non-insulin-dependent diabetes mellitus (NIDDM)** | | |
| 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** | | |
| 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 (continued)**

| Baseline Demographics | Number | Percentage |
|------------------------|--------|------------|
| **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% |
| **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)** | | |
| Yes | 2175 | 34.0% |
| No | 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)** | | |
| Yes | 5325 | 83.2% |
| No | 1054 | 16.5% |
| Unknown | 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 χ² Analysis.a

| Risk Factors | No Weight-Bearing | Weight-Bearing | P Value |
|--------------|-------------------|----------------|---------|
| **Age (years)** |                   |                |         |
| 65-79        | 474 (28.9%)       | 1495 (31.4%)  | .029    |
| 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/m²)** |       |                | .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 | 0 (0%) | 6 (0.1%) |  |
| Native       | 1 (0.1%)          | 3 (0.1%)      |         |
| Native Hawaiian or Pacific Islander | 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%)     |         |
| Ventilator dependent | 6 (0.4%) | 2 (0.0%) | .001 |
| History of severe COPD | 204 (12.4%) | 481 (10.1%) | .008 |
| Ascerts      | 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%) |  |

Table 2. (continued)

| Risk Factors | No Weight-Bearing | Weight-Bearing | P Value |
|--------------|-------------------|----------------|---------|
| Prior history of sepsis |                   |                |         |
| Prior history of septic shock |                   |                |         |

(continued)
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.\textsuperscript{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 mobility,\textsuperscript{36-38} a recent study appears to suggest that existing disorientation should not be a major red flag in preventing mobility.\textsuperscript{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.\textsuperscript{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\textsuperscript{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.\textsuperscript{28} Ruedi et al\textsuperscript{43} and Lichtbau\textsuperscript{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 each provider’s patients.\textsuperscript{45} Australian literature reported that WBAT was prescribed in 77% of hip fracture patients.\textsuperscript{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 2. (continued)

| Risk Factors | No Weight-Bearing | Weight-Bearing | P Value |
|--------------|-------------------|----------------|---------|
| July to September | 398 (24.3%) | 1129 (23.7%) | 0.255 |
| October to December | 395 (24.1%) | 1342 (28.2%) | 0.012 |
| Time from admission to operation (days) | <.001 | | |
| ≤1 day | 1206 (73.5%) | 3765 (79.0%) | <.001 |
| >1 day | 434 (26.5%) | 999 (21.0%) | |
| Total operative time (minutes) | <.001 | | |
| 0-45 | 598 (35.9%) | 1744 (36.6%) | 0.292 |
| 46-90 | 712 (43.4%) | 2235 (46.9%) | 0.368 |
| >90 | 340 (20.7%) | 785 (16.5%) | 0.001 |

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.

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

| 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.

*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.
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 Orthopaedic 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

### 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 | 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    |       |
| 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]    | <.001   |       |
| None                                          | Ref                 |         |       |
| Preoperative dementia                         |                     |         |       |
| Yes                                           | 1.36 [1.18-1.58]    | <.001   |       |
| No                                            | Ref                 |         |       |
| Preoperative delirium                         |                     |         |       |
| Yes                                           | 1.30 [1.08-1.57]    | <.001   |       |
| 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]    | <.001   |       |
| 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]    | <.001   |       |
| 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    |       |

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

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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.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This project is made possible through a patient safety and advancement grant funded by The Ohio State University Wexner Medical Center. Two authors have received other funding from the National Institutes of Health grant R03AG060177 (CEQ), Davis Bremer Path to Pre K through The Ohio State University Wexner Medical Center (CEQ) and Simpson-Cummins Endowment (CQY), which is related to the research, authorship, and/or publication of this article: This project is made possible through a patient safety and advancement grant funded by The Ohio State University Wexner Medical Center. Two authors have received other funding from the National Institutes of Health. This work was supported by: The Ohio State University Wexner Medical Center (CEQ), Davis Bremer Path to Pre K through The Ohio State University Wexner Medical Center (CEQ) and Simpson-Cummins Endowment (CQY), which is related to the research, authorship, and/or publication of this article: This project is made possible through a patient safety and advancement grant funded by The Ohio State University Wexner Medical Center. Two authors have received other funding from the National Institutes of Health. This work was supported by: The Ohio State University Wexner Medical Center (CEQ), Davis Bremer Path to Pre K through The Ohio State University Wexner Medical Center (CEQ) and Simpson-Cummins Endowment (CQY). Several authors disclose consulting for the Johnson and Johnson Hip Fracture Advisory Board and Simpson-Cummins Endowment (CQY), which is related to the research, authorship, and/or publication of this article: This project is made possible through a patient safety and advancement grant funded by The Ohio State University Wexner Medical Center. Two authors have received other funding from the National Institutes of Health. This work was supported by: The Ohio State University Wexner Medical Center (CEQ), Davis Bremer Path to Pre K through The Ohio State University Wexner Medical Center (CEQ) and Simpson-Cummins Endowment (CQY). Several authors disclose consulting for the Johnson and Johnson Hip Fracture Advisory Board and Helius Medical Technologies (CQY).

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