Clinical Predictors of Prolonged Hospitalization in Patients with Hip Fracture

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Abstract

- *Objective:* To determine if common clinical variables can predict increased length of stay (LOS) in patients over 50 years of age with fall-related hip fracture.
- *Methods:* We retrospectively analyzed the records of 183 consecutive patients 50 years or older admitted with hip fracture to a 750-bed teaching hospital. Data collected included demographic information, type of fracture, major comorbidities, type of surgical procedure, various admission laboratory values, postoperative complications, and LOS.
- *Results:* The patients' mean age ± SD was 80.2 ± 10.2 years, 79% were female, and 85% were community dwellers. 90% of fractures involved the trochanteric region, and 92% underwent open reduction internal fixation. One patient died while 87% were discharged to an extended care facility or rehabilitation unit. On multivariable linear regression analysis, there were 6 independent predictors of increased LOS: postoperative respiratory failure ($P < 0.001$), postoperative infection ($P < 0.001$), postoperative cardiac complication ($P = 0.001$), postoperative delirium ($P = 0.03$), type of surgical procedure ($P = 0.001$), and admission platelet count ($P = 0.004$).
- *Conclusion:* Elderly patients with fall-related hip fractures with a low admission platelet count, who undergo total hip arthroplasty, or who develop postoperative respiratory failure, infection, cardiac dysfunction, or delirium have a longer hospital LOS. However, hospital morbidity is very low in this population, reinforcing the safety of surgical intervention in elderly patients with hip fracture.

Hip fracture constitutes a major cause of morbidity and mortality among elderly patients admitted to acute care hospitals and places a significant burden on both the patient and the health care system [1–3]. Acute medical complications of hip fracture that may be encountered in-hospital include venous thromboembolism, aspiration syndromes, catheter-related infections, decubitus ulcers, myocardial infarction, heart failure, and stroke [4–7]. Any of these conditions can result in prolonged functional recovery as well as an increased hospital length of stay (LOS) and the need for discharge to an extended care facility [1,2,4]. Gender differences with regard to prolonged time to postoperative ambulation, postoperative medical complications, need for institutional care, in-hospital death, and 1-year mortality have been noted in male patients with hip fracture [8,9]. Additional clinical risk factors for a poor outcome have been described in the literature and include advanced age [1,10], pathologic fracture due to malignancy [2], pre-existing medical illness [4], American Society of Anesthesiologists (ASA) operative risk of 3 to 4 [8], and postoperative delirium [11,12]. Poor premorbid ambulatory status has been demonstrated to correlate with prolonged recovery and need for institutional care after discharge [5].

In addition to the above clinical factors, some laboratory parameters have been found to correlate with adverse outcomes associated with hip fracture, most often in elderly patients. Elevation of fibrinogen [13], C-reactive protein [14], plasma viscosity [14], and serum cortisol [15] have been documented in patients presenting with hip fracture, although the relationship to outcome is not robust. Conversely, injury-associated decreases in absolute lymphocyte count [16,17], hemoglobin [18], and albumin [17,19] have been shown to be associated with increased LOS and short-term postoperative mortality.

Hip fractures constitute a significant percentage of admissions to acute care facilities. Identifying clinical and laboratory abnormalities that predict prolonged hospitalization may aid clinicians in providing timely medical care and assist ancillary staff and families with discharge planning. We conducted a retrospective review of patients admitted with acute hip fracture to ascertain whether demographic and clinical features predict prolonged hospitalization.

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Methods

We retrospectively analyzed the medical records of 183 consecutive patients aged 50 years and older admitted over a 2-year period with a fall-related acute hip fracture through the emergency department of Miami Valley Hospital, a 750-bed regional referral facility and major teaching hospital of Wright State University School of Medicine in Dayton, Ohio. Patients most likely to receive perioperative medical care by hospitalists were analyzed (ie, those over age 50 presenting with a fall-related fracture). Patients with hip fractures related to motor vehicle accidents or penetrating trauma were excluded. The following variables were recorded: age, gender, type of fracture (trochanteric region or femoral neck), side of fracture, type of procedure (open reduction and internal fixation [ORIF], hemiarthroplasty [HA], total hip arthroplasty [THA]), major medical illnesses (cardiac, chronic renal failure, diabetes mellitus, stroke, malignancy, chronic obstructive pulmonary disease), major postoperative complications (respiratory failure, cardiovascular problem, sepsis/infection, stroke, acute renal failure), in-hospital LOS, and disposition (home, extended care facility, or death). In addition, the following admission laboratory variables were recorded: total white blood cell (WBC) count, absolute neutrophil count (ANC), absolute lymphocyte count (ALC), platelet count, and hemoglobin.

Statistical Analysis

Means and standard deviations are reported for continuous variables, and frequencies and percentages are reported for categorical variables. The univariate relationship between a predictor and LOS was examined with Pearson correlation for continuous predictors and with the independent samples *t* test or analysis of variance for categorical predictors. Those predictors that were statistically significant ($\alpha = 0.05$) on a univariate basis were entered into a multivariable linear regression model to indentify independent predictors of LOS. Independent predictors are those demographic and clinical variables that remain significant after all other variables that were significant on a univariate basis are controlled. Finally, a clinical predictor rule was formulated using the standardized beta coefficients (SBC) for independent predictors generated from the multivariable equation.

Results

We identified 183 patients who met our criteria for analysis. Most patients were elderly (mean age ± SD, 80.2 ± 10.2 years) and female (79%). The majority of fractures involved the trochanteric region (90%) and were equally distributed between the left ($n = 93$) and right ($n = 90$) sides. ORIF was the most commonly performed surgical procedure (92%). Most patients were community dwelling or admitted from home (85%), and only a small minority harbored a documented infection upon admission (5%). Eighty-seven percent of patients were discharged to an extended care facility, 12% to home, and 1 patient died in the hospital.

Table 1 shows the categorical demographic and clinical variables and their relationship to LOS. Six predictors were significantly related to increased LOS: cardiac comorbidity ($P = 0.001$); type of surgery (THA; $P = 0.007$); postoperative respiratory failure ($P < 0.001$); postoperative infection ($P = 0.01$); postoperative cardiac complication ($P = 0.003$); and postoperative delirium ($P = 0.002$).

Table 2 shows the correlation of demographic and laboratory variables with LOS. The WBC count, platelet count, and hemoglobin values were available for all 183 patients, while 157 subjects had ANC and ALC data available. Decreased platelet count correlated significantly with increased LOS ($r = –0.17$, $P = 0.02$).

The 7 significant univariate predictors of increased LOS (cardiac comorbidity, type of surgery, postoperative respiratory failure, postoperative infection, postoperative cardiac complication, postoperative delirium, and admission platelet count) were entered into a multivariable linear regression analysis. Six of these predictors (all except cardiac comorbidity) were independent predictors of prolonged LOS (**Table 3**).

We developed a clinical prediction rule based on the strength of the SBCs for these 6 independent predictors (ie, [SBC of predictor/SBC sum for all 6 predictors] × 100). With 38% of the sum of the SBCs, postoperative respiratory failure was the strongest predictor of increased LOS. Weaker predictors were postoperative infection (17%), postoperative cardiac complication (14%), type of surgical procedure (14%), postoperative delirium (9%), and admission platelet count (8%). Clinical prediction rule weights were calculated by dividing the SBC percent of an independent predictor by 10 and rounding to the nearest 0.5 (Table 3). With a maximum of 11 points, the 6 independent predictors were assigned the following weights: postoperative respiratory failure (4 points), postoperative infection (2 points), postoperative cardiac complication (1.5 points), type of surgical procedure (THA; 1.5 points), postoperative delirium (1.5 points), and admission platelet count (1 point) (Table 3).

Discussion

Fall-related hip fractures typically affect elderly persons, who often possess a variety of medical comorbid conditions such as cardiovascular disease, diabetes mellitus, cerebrovascular disease, cancer, or pulmonary dysfunction [1,4,20,21]. Indeed, the mean age of patients in our study was 80.2 years, which is similar to 2 large studies in which the median age was 82 years [1,2]. Due to the advanced age of the hip fracture population and the common coexistence of medical issues and polypharmacy, hospitalists and other medical physicians are often consulted to comanage these

Table 1. Hospital Length of Stay Associated with Various Categorical Variables (n = 183)

Characteristic	*n* (%)	Mean LOS ± SD	*P* Value*
Gender			0.95
Male	38 (21)	5.84 ± 3.58	
Female	145 (79)	5.80 ± 3.84	
Side of fracture			0.58
Right	90 (49)	5.97 ± 4.12	
Left	93 (51)	5.66 ± 3.43	
Type of fracture			0.34
Trochanteric	165 (90)	5.72 ± 3.82	
Femoral	18 (10)	6.61 ± 3.31	
Comorbidity cardiac			0.001
Yes	68 (37)	7.22 ± 5.39	
No	115 (63)	4.97 ± 1.96	
Comorbidity diabetes mellitus			0.88
Yes	36 (20)	5.89 ± 4.52	
No	147 (80)	5.79 ± 3.59	
Comorbidity stroke			0.95
Yes	25 (14)	5.76 ± 2.59	
No	158 (86)	5.82 ± 3.94	
Comorbidity chronic renal failure†			0.63
Yes	19 (10)	6.21 ± 4.14	
No	163 (90)	5.77 ± 3.75	
Comorbidity cancer			0.61
Yes	26 (14)	5.46 ± 2.34	
No	157 (86)	5.87 ± 3.97	
Comorbidity COPD			0.16
Yes	15 (8)	7.13 ± 5.34	
No	168 (92)	5.69 ± 3.60	
Preadmission residence‡			0.20
Home	154 (85)	5.84 ± 3.68	
Extended care facility	27 (15)	4.89 ± 2.75	
Infection on admission			0.59
Yes	9 (5)	7.22 ± 7.92	
No	174 (95)	5.74 ± 3.46	
Type of surgery			0.007
ORIF	169 (92)	5.67 ± 3.78	
Hemiarthroplasty	12 (7)	6.33 ± 2.19	
Total hip arthroplasty	2 (1)	14.00 ± 0.00	
Complication respiratory failure			< 0.001
Yes	9 (5)	16.44 ± 9.08	
No	174 (95)	5.26 ± 2.24	
Complication infection			0.01
Yes	19 (10)	10.95 ± 8.61	
No	164 (90)	5.21 ± 2.08	
Complication cardiac			0.003
Yes	20 (11)	9.90 ± 6.09	
No	163 (89)	5.31 ± 3.06	
Complication delirium			0.002
Yes	39 (21)	8.46 ± 6.43	
No	144 (79)	5.09 ± 2.18	
Complication acute renal failure			0.13
Yes	9 (5)	10.56 ± 8.96	
No	174 (95)	5.56 ± 3.17	

COPD = chronic obstructive pulmonary disease; ORIF = open reduction and internal fixation.

*Independent samples *t* test for all characteristics except type of surgery (analysis of variance).

†n = 182; 1 missing datum.

‡n = 181; 2 missing data.

patients during the pre- and postoperative period. Medical consultants are often asked to "clear" the patient before surgery, comment on whether to proceed with surgery in the setting of a laboratory abnormality, or assist in the postoperative course in order to decrease LOS and improve outcome. Since prolonged hospitalization is associated with increased cost and may predispose elderly patients to nosocomial complications [1–4], we sought to determine whether routine clinical variables could predict increased LOS in patients ≥ 50 years of age admitted through the emergency department with fall-related hip fracture.

The majority of patients were female (79%) and underwent ORIF (92%), which is consistent with the predominance of trochanteric fractures (90%) present in our study population. Additionally, 85% of patients were community-dwelling, either residing in their own home, a family member's home, or an independent-living environment, which is consistent with prior reports on this population [1,4]. The presence of premorbid cardiovascular disease was 37%, which is similar to prior studies with cardiovascular disease affecting 24% to 40% of hip fracture patients [1,4]. On univariate analysis, the presence of a premorbid cardiac

Table 2. Correlation of Clinical Characteristics with Hospital Length of Stay (LOS)

Characteristic	*n*	Mean ± SD	Correlation with LOS*	*P* Value
Age, yr	183	80.2 ± 10.5	0.04	0.62
WBC count	183	10,610 ± 3308	0.02	0.76
ANC	157	8724 ± 3290	–0.01	0.90
Platelet count	183	252,164 ± 91,298	–0.17	0.02
ALC	157	1144 ± 571	–0.04	0.63
Hemoglobin	183	12.2 ± 1.7	–0.12	0.10
LOS, d	183	5.81 ± 3.78		

ALC = absolute lymphocyte count; ANC = absolute neutrophil count; WBC = white blood cell.

*Pearson correlation.

disorder was associated with increased LOS (7.22 ± 5.39 days vs. 4.97 ± 1.96 days, $P = 0.001$), although this did not predict LOS on multivariable linear regression analysis. The prevalence of other premorbid medical issues such as diabetes mellitus, prior stroke, chronic renal failure, cancer, and obstructive lung disease are also similar to the hip fracture population [1,2,4]. Analagous to premorbid cardiac disease, none of these conditions predicted increased LOS in our study. The reason for this is speculative but could be related to compensated and well-controlled disease, which is consistent with the large percentage of patients who were community-dwellers prior to their fractures. Intuitively, clinicians may associate most of these identified postoperative clinical predictors with an increased LOS. However, we believe that postoperative predictors are useful in identifying those patients who may require more meticulous attention in a step-down or intensive care unit as opposed to a general orthopaedic ward. Indeed, patients with hip fracture are typically admitted to the orthopaedic unit, often without medical comanagement, and return there after surgery. If any of the postoperative predictors we identified are noted during a patient's recovery, patient transfer and prompt medical consultation may be indicated.

We analyzed not only major postoperative complications but also preoperative laboratory tests that are frequently obtained in the hip fracture population. Of the laboratory tests subjected to univariate analysis, only preoperative platelet count correlated with increasing LOS ($r = –0.17$, $P = 0.02$), with lower platelet counts being predictive of increasing LOS. Also, on univariate analysis, increased LOS was associated with postoperative respiratory failure, postoperative infection, postoperative cardiac complication, and postoperative delirium. Additionally, THA was predictive of increased LOS, although there were only 2 patients in our study who underwent this procedure.

We developed a clinical prediction model that may aid clinicians in identifying those patients who are at increased risk for a prolonged LOS. Indentifying these patients may aid the physician in providing perioperative care to those requiring significant postoperative attention. Additionally, identifying patients at risk for increased LOS may aid families and discharge planners in preparing for discharge, whether it be to an extended care facility (as was the case in 87% of our patients) or to a home environment. Using multivariable linear regression, we developed a clinical prediction rule based on the 6 independent predictors of LOS. The percentage and numerical weights of these 6 predictors were postoperative respiratory failure (38% or 4 points), postoperative infection (17% or 2 points), postoperative cardiac complication (14% or 1.5 points), type of surgery (14% or 1.5 points), postoperative delirium (9% or 1 point), and admission platelet count (8% or 1 point). This prediction rule derived from our patient sample should be verified with other cohorts of hip fracture patients. Nevertheless, our results suggest that the presence of any one or a combination of these predictors may lead to a longer LOS. However, predicting how long the postoperative LOS will be in an individual patient is not possible with our data.

The only preoperative laboratory predictor that was independently significant on multivariable linear regression is admission platelet count, with decreasing counts correlating with increasing LOS. The reason for this is unclear, but may be related to fat embolism syndrome, which results from the release of bone marrow contents into the systemic circulation leading to thrombocytopenia, lung injury, nervous system dysfunction, and occasionally, disseminated intravascular coagulation [22,23]. Other admission laboratory values such as total WBC, ANC, and ALC were not predictive of increased LOS, although there was a trend for lower admission hemoglobin ($P = 0.10$), which is similar to prior studies [18]. The lack of correlation between leukocytosis/neutrophilia and increased LOS suggests that the presence of these findings should not, by themselves, lead to postponing surgery.

Notably, only 1 patient in our cohort died, which attests to the safety of surgical intervention in the elderly hip fracture population, and that age alone or the presence of premorbid medical conditions should not deter surgical intervention. The reason for the low mortality rate in our study may relate to the high prevalence of community-dwellers, a predominance of trochanteric fractures, and the vast majority of patients undergoing ORIF as opposed to more invasive HA or THA. Indeed patients who underwent HA and THA had longer LOS compared with ORIF, although only THA was significantly predictive.

Strengths of our study include analysis of a typical population of hip fracture patients since our center is a large community-based regional referral hospital. Also, we did

Table 3. Hospital Length of Stay (LOS) Among Elderly Patients with a Hip Fracture: Multivariable Linear Regression

Characteristic	*n*	Standardized Beta Coefficient (SBC)	*P* Value*	Clinical Prediction Rule Percent†	Clinical Prediction Rule Weight‡
Complication respiratory failure	183	–0.479	< 0.001	38%	4
Complication infection	183	–0.208	< 0.001	17%	2
Complication cardiac	183	–0.178	0.001	14%	1.5
Type of surgery	183	0.172	0.001	14%	1.5
Complication delirium	183	–0.114	0.03	9%	1
Platelet count	183	–0.105	0.04	8%	1

*Comorbidity cardiac ($P = 0.12$) not an independent predictor of LOS.

†(SBC of predictor/SBC sum for all 6 predictors) × 100.

‡SBC percentage/10 rounded to the nearest 0.5.

not analyze hip fractures in younger patients or those involved in motor vehicle accidents, as these patient categories do not represent the typical patient referred for medical consultation. Weaknesses of our study include the retrospective nature, the relatively small number of cases analyzed, and a clinical prediction rule that primarily includes postoperative predictors. However, we believe our prediction rule will be useful for the hospitalist or other medical consultant when assessing hip fracture patients in the postoperative period, since this may be the first instance in which medical consultation is requested. Identification of postsurgical respiratory issues, infection, cardiac complications, and delirium may aid the medical physician in deciding patient disposition and level of care. Since we analyzed all consecutive cases of fall-related hip fracture in patients over age 50 years, bias and confounding are unlikely.

In conclusion, patients admitted to the hospital with a fall-related hip fracture are most often community-dwellers and have a very low in-hospital mortality rate, less than 1% in our study. Also, common premorbid medical issues are not predictive of increased LOS nor are admission hematologic variables, with the exception of platelet count. However, the presence of any 1 or a combination of postoperative complications (ie, respiratory failure, infection, cardiac complication, delirium), admission platelet count, or THA independently predict increased LOS. Identifying patients with these predictors may allow more focused attention to medical care and aid with discharge plans both for the health care team and the patient's family. A verification study of our derived clinical prediction rule would be useful to assess its widespread applicability to the elderly hip fracture population.

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References

1. Roche JJ, Wenn RT, Sahota O, Moran CG. Effect of comorbidites and postoperative complications on mortality after hip fracture in elderly people: prospective observational cohort study. BMJ 2005;331:1374.
2. Jiang HX, Majumdar SR, Dick DA, et al. Development and initial validation of a risk score for predicting in-hospital and 1-year mortality in patients with hip fractures. J Bone Miner Res 2005;20:494–500.
3. Zuckerman JD. Hip fracture. N Engl J Med 1996;334:1519–25.
4. Lawrence VA, Hilsenbeck SG, Noveck H, et al. Medical complications and outcomes after hip fracture repair. Arch Intern Med 2002;162:2053–7.
5. Merchant RA, Lui KL, Ismail NH, et al. The relationship between postoperative complications and outcomes after hip fracture surgery. Ann Acad Med Singapore 2005;34:163–8.
6. Sircar P, Godkar D, Mahgerefteh S, et al. Morbidity and mortality among patients after hip fractures surgically repaired within and after 48 hours. Am J Ther 2007;14:508–13.
7. Beringer TRO, Clarke J, Elliott JRM, et al. Outcome following proximal femoral neck fracture in northern Ireland. Ulster Med J 2006;75:200–6.
8. Endo Y, Aharonoff GB, Zuckerman JD, et al. Gender differences in patients with hip fracture: a greater risk of morbidity and mortality in men. J Orthop Trauma 2005;19:29–35.
9. Diamond TH, Thornley SW, Sekel R, Smerdely P. Hip fracture in elderly men: prognostic factors and outcomes. Med J Aust 1997;167:412–5.
10. Ramanathan TS, Moppett IK, Wenn R, Moran CG. POSSUM scoring for patients with fractured neck of femur. Br J Anaesth 2005;94:430–3.
11. Cree M, Soskoine CL, Belseck E, et al. Mortality and institutionalization following hip fracture. J Am Geritatr Soc 2000;48:283–8.
12. Edelstein DM, Aharonoff GB, Karp A, et al. Effect of postoperative delirium on outcome after hip fracture. Clin Orthop Relat Res 2004;22:195–200.

13. Sedlar M, Kudrnova Z, Trca S, et al. Inflammatory response in patients undergoing hip surgery due to osteoarthritis or different types of hip fractures. Osteoarthritis Cartilage 2008; 16:26–33.
14. Okafor B, MacLellan G. Postoperative changes of erythrocyte sedimentation rate, plasma viscosity, and C-reactive protein levels after hip surgery. Acta Orthop Belg 1998;64:52–6.
15. Butcher SK, Killampalli V, Lascelles D, et al. Raised cortisol: DHEAS ratios in the elderly after injury: potential impact upon neutrophil function and immunity. Aging Cell 2005;4:319–24.
16. Conlan DP. Value of lymphocyte counts as a prognostic index of survival following femoral neck fractures. Injury 1989;20: 352–4.
17. Koval KJ, Maurer SG, Su ET, et al. The effects of nutritional status on outcome after hip fracture. J Orthop Trauma 1999; 13:164–9.
18. Gruson KI, Aharonoff GB, Egol KA, et al. The relationship between admission hemoglobin level and outcome after hip fracture. J Orthop Trauma 2002;16:39–44.
19. Marinella MA, Markert RJ. Admission serum albumin and length of hospitalization in elderly patients. South Med J 1998; 91:851–4.
20. Tornetta P, Mostafavi H, Riina J, et al. Morbidity and mortality in elderly trauma patients. J Trauma 1999;46:702–6.
21. Pulido L, Parvizi J, Macgibeny M, et al. In hospital complications after total joint arthroplasty. J Arthroplasty 2008;23: 139–45.
22. Marinella MA. Frequently overlooked diagnosis in acute care. Philadelphia: Hanley & Belfus; 2003:55–8.
23. Keith RG, Mahoney LJ, Garvey MB. Disseminated intravascular coagulation: an important feature of the fat embolism syndrome. Can Med Assoc J 1971;106:74–6.