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CLINICAL RESEARCH

Does Early Functional Outcome Predict 1-year Mortality in Elderly Patients With Hip Fracture?

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Abstract
Background Hip fractures in the elderly are followed by considerable risk of functional decline and mortality.
Questions/purposes The purposes of this study were to (1) explore predictive factors of functional level at discharge, (2) evaluate 1-year mortality after hip fracture compared with that of the general population, and (3) evaluate the affect of early functional outcome on 1-year mortality in patients operated on for hip fractures.
Methods A total of 228 consecutive patients (average age, 77.6 ± 7.4 years) with hip fractures who met the inclusion criteria were enrolled in an open, prospective, observational cohort study. Functional level at discharge was measured with the motor Functional Independence Measure (FIM) score, which is the most widely accepted functional assessment measure in use in the rehabilitation community. Mortality rates in the study population were calculated in absolute numbers and as the standardized mortality ratio. Multivariate regression analysis was used to explore predictive factors for motor FIM score at discharge and for 1-year mortality adjusted for important baseline variables.
Results Age, health status, cognitive level, preinjury functional level, and pressure sores after hip fracture surgery were independently related to lower discharge motor FIM scores. At 1-year followup, 57 patients (25%; 43 women and 14 men) had died. The 1-year hip fracture mortality rate compared with that of the general population was 31% in our population versus 7% for men and 23% in

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
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our population versus 5% for women 65 years or older. The 1-year standardized mortality rate was 341.3 (95% CI, 162.5–520.1) for men and 301.6 (95% CI, 212.4–391.8) for women, respectively. The all-cause mortality rate observed in this group was higher in all age groups and in both sexes when compared with the all-cause age-adjusted mortality of the general population. Motor FIM score at discharge was the only independent predictor of 1-year mortality after hip fracture.

Conclusions Functional level at discharge is the main determinant of long-term mortality in patients with hip fracture. Motor FIM score at discharge is a reliable predictor of mortality and can be recommended for clinical use.

Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Patients with hip fractures often lose independence and do not recover their preinjury level of function [24], and many die during the year after the injury [1]. With the aging of our population, the social and economic burden of hip fractures is expected to increase [19]. There is some evidence that the devastating consequences of hip fracture may be decreased with multidisciplinary inpatient rehabilitation [13]. Recognition of variables that influence mortality at an early stage is needed to set realistic rehabilitation goals, adequately allocate rehabilitation resources, and optimize recovery after hip fracture. The most frequently reported predictors of mortality after hip fracture are male sex, advanced age, and poor general health status [35, 41]. However, data regarding potential predictive value of early functional outcome after hip fracture have not been sufficiently investigated [3].

The main objectives of this study were to (1) explore predictive factors of functional level at discharge, (2) evaluate 1-year mortality after hip fracture compared with that of the general population, and (3) evaluate the impact of early functional outcome on 1-year mortality in patients operated on for hip fractures. The null hypothesis was that functional level at discharge does not predict 1-year mortality after hip fracture.

Patient and Methods

All adult patients 65 years or older with an acute hip fracture who were admitted consecutively to a university-associated orthopaedic hospital in Serbia between January 2010 and January 2011 were enrolled in an open, prospective, observational cohort study. We excluded patients with subtrochanteric and pathologic fractures, major concomitant injuries, multiple trauma, malignant diseases, imminent death as a result of an end-stage disease, inability to walk before fracture, and nonoperative treatment resulting from high surgical risk. Additionally, we also excluded all patients whose total length of stay (LOS) exceeded 30 days. The study was conducted according to the Helsinki Declaration and approved by the University's institutional review board (tracking number 440/III-8). All subjects gave written informed consent to participate in the study.

At admission, we assessed all subjects through patient or proxy interview regarding sociodemographic variables (age, sex, marital level, preinjury living conditions), cognitive level, prefracture functional level, and functional level at admission. During the primary hospital stay, waiting time for surgery, surgical risk, type of fracture, surgical method, type of anesthesia, functional outcome at discharge, presence of postoperative complications, and LOS were recorded. All assessments were performed by one tester (EDR), who was not involved in the treatment of the patients, excluding the American Society of Anesthesiologists (ASA) physical status classification of surgical risk, and the type of fracture, which were classified by the attending anesthesiologists and surgeons, respectively. Cognitive level at admission was assessed with the Short Portable Mental Level Questionnaire (SPMSQ) [32]. The 10-item questionnaire classifies the patient's cognitive level depending on the number of correct answers as lucid (8–10), mild to moderate cognitive dysfunction (3–7), and severe cognitive dysfunction (0–2). In patients with an SPMSQ score less than 3, all observed variables, except for the cognitive level, were collected from a proxy. Prefracture functional level, functional level at admission, and discharge (180.4 days postoperatively) were assessed by the motor subscale of the Functional Independence Measure (motor FIM) [8]. The FIM score has been used in different prospective and retrospective cohort studies in patients with hip fractures, and its reliability has been seen directly with patient response and with proxy response [16]. The motor FIM scale is comprised of 13 items and rates a patient's independence in self-care (feeding, grooming, bathing, dressing upper and lower body, toileting), sphincter control (bladder management and bowel management), transfer (bed, chair, wheelchair transfer, toilet, and tub or shower transfer), and locomotion (walking, climbing stairs). Ratings for each item range from 1 (total assistance) to 7 (complete independence). We used the ASA [30] rating of operative risk to group patients' physical level into one of five categories, ranging from 1 (healthy) to 5 (moribund). For the purpose of this study, ASA Classes 1 and 2 were combined, and ASA Classes 3 and 4 were combined. No patient in our study was graded as moribund. All patients with femoral neck fractures (139 patients [61%]) underwent bipolar hemiarthroplasty, whereas all patients with intertrochanteric fractures (89 [39%]) underwent open reduction and internal fixation (ORIF) with a dynamic hip screw. In all patients, depending on overall postoperative health status, early assisted ambulation was encouraged on the first postoperative day with weightbearing as tolerated, and all patients followed a standardized postoperative rehabilitation program.

At discharge, we assessed functional level, presence of postoperative medical complications, and LOS. Observed postoperative medical complications were delirium, pneumonia, pulmonary embolism, deep venous thrombosis (DVT), urinary tract infection (UTI), deep wound infection, pressure sores, and prosthetic dislocation. The Confusion Assessment Method was used to assess delirium on a daily basis [17]. The diagnosis of pneumonia was based on the patient's report of symptoms, combined with examination of the chest, and was confirmed on chest radiography. Lung scintigraphy was used to confirm symptomatic pulmonary embolism. Symptomatic DVT was confirmed by ultrasonography. UTI was defined as significant bacteriuria if the patient had symptoms of cystitis or pyelonephritis. Shea's classification system, as described by Stausberg and Kiefer [44], has been used for staging pressure ulcers. Deep wound infection was diagnosed by the presence of local symptoms (wound drainage, erythema, swelling), systemic symptoms (fever, chills, and generalized malaise), and by blood tests (erythrocyte sedimentation rate and the C-reactive protein level). Unfortunately, many periprosthetic infections do not exhibit obvious signs and symptoms of infection.

Continuous variables are presented in terms of mean values with SD or median and interquartile range depending on Kolmogorov-Smirnov test of distribution normality. Categorical values were summarized as absolute frequencies and percentages.

One-year mortality was assessed by telephone interview; this was compared with mortality of the general population. First, crude rates were compared with all-cause mortality rates in the general population 65 years or older. Second, the age-specific mortality rates (calculated for the following age groups: 65–74 years, 75–84 years, and $\geq$ 85 years) in patients with hip fractures and in the general population were compared. We then used indirect standardization to compare the mortality of our patients with the general population mortality. The general population comprised people who resided in Belgrade in 2010 and who were 65 years or older. Population data were divided into the three above-mentioned age categories. We calculated the standardized mortality ratio (SMR), which was expressed as the ratio of observed and expected cases. The expected number is based on general population mortality rate. Using age- and sex-specific mortality data from the National Institute of Public Health, the 95% CIs were calculated assuming a Poisson distribution. The Kaplan-Meier method was used to estimate the probability of overall survival at 1 year after fracture.

We used multivariate linear regression analysis with the enter method to explore predictive factors for motor FIM at discharge. Cox multivariate proportional hazard regression analysis with the enter method was used to assess the relationship between discharge variables and 1-year mortality adjusted on important baseline variables. For the purpose of both regression analyses, all variables were grouped into six groups: sociodemographic (sex, age, martial level, preinjury residence), physical (ASA), cognitive (SPMSQ), functional level before injury (preinjury motor FIM), surgical (type of fracture, type of anesthesia, type of surgical intervention, waiting time for surgery), and those related to in-hospital outcome (motor FIM at admission and discharge, presence of complications, LOS). In the first model we performed univariate analysis to investigate the association between all individual variables and outcome, motor FIM at discharge, and mortality, respectively. Only the univariate predictors that showed a major relationship with the outcome were subsequently tested in the six group models. Finally, all factors that were substantially related to the outcome in the previous models were tested together in the final model. In independent predictors of functional level at discharge after hip fractures, the significance level for all statistical tests was set at 0.05.

During the study period, 384 patients had hip fractures and were examined for eligibility. Two hundred twenty-eight patients (183 females [80%]) were confirmed eligible and were included in the study. The average age of the patients was 77.6 ± 7.4 years (range, 65–96 years; Table 1). One patient (0.8%) died during the acute hospital stay; therefore, motor FIM score statistics are presented for 227 patients. Lost-to-followup and missed data were addressed by maintaining contact with participants at regular intervals, and collecting information for friends or relatives who would know how to reach a participant if she or he should move. There was missing data for one patient (0.4%) regarding motor FIM score at discharge, and for six patients (2.6%) regarding type of anesthesia. No other data were missing.

Results

Patients who were older, not married, had a worse health status, had a lower cognitive level, worse functional level before injury, regional anesthesia, delirium, pressure sores, and a longer LOS, had lower motor FIM scores at discharge in the univariate linear regression analysis

Table 1. Baseline and discharge level characteristics of study patients

Group of variables	Variables	N = 228 patients
Sociodemographic	Age groups† (years, mean ± SD)	77.6 ± 7.4
	Gender	
	Male	45 (19.7)
	Female	183 (80.3)
	Marital status‡	
	Married	72 (31.6)
	Other	156 (68.4)
	Preinjury residence‡	
	Independent	223 (31.6)
	Institution	2 (2.2)
Physical	ASA‡	
	Classes 1, 2	139 (61.0)
	Classes 3, 4	89 (39.0)
Cognitive status	SPMSQ† (median with interquartile range)	8 (0–10)
Functional level before injury	Motor FIM before injury† (median with interquartile range)	89 (21–91)
In-hospital outcome	Perioperative data	
	Type of fracture‡	
	Femoral neck	139 (61.0)
	Intertrochanteric	89 (39.0)
	Waiting time for surgery‡	
	< 48 hours	25 (11.0)
	≥ 48 hours	203 (89.0)
	Type of surgical procedure‡	
	Hemiarthroplasty	139 (61.0)
	Internal fixation	89 (39.0)
	Type of anesthesia‡	
	General	112 (50.5)
	Spinal	110 (49.5)
	Motor FIM admission† (median with interquartile range)	26 (13–30)
	Motor FIM discharge† (median with interquartile range)	46 (13–83)
	Complications‡	92 (40.4)
	Pressure sores‡	38 (16.7)
	New-onset delirium‡	32 (14.0)
	Urinary tract infection‡	8 (13.5)
	Deep venous thrombosis‡	0 (0)
	Pulmonary embolism‡	2 (0.9)
	Deep wound infection‡	2 (0.9)
	Pneumonia‡	5 (1.5)
	Prosthesis dislocation‡	8 (3.5)
	Length of hospital stay†	18 (1–30)

† Values given as mean with SD (mean ± SD), or as median with interquartile range depending on the normality of distribution; ‡values given as number of patients with percentage in parentheses; ASA = American Society of Anesthesiologists; SPMSQ = Short Portable Mental Level Questionnaire; FIM = Functional Independence Measure.

(Table 2). All of the variables, except for type of marital status, type of anesthesia, delirium, and LOS, were independently related to motor FIM at discharge in the final multivariate model. The final multivariate model significantly predicted FIM score at discharge in the regression analysis. The adjusted R^2 for the final regression model was 0.61 with an F statistic of 41 ($p < 0.001$).

At 1-year followup, 57 patients (25%; 43 women and 14 men) had died. One patient (0.4%) was lost to followup. The mean time to death was 90.9 days (Fig. 1). One-year hip fracture mortality rate compared with that of the general population was 31% in our population versus 7% in men and 23% in our population versus 5% for women 65 years or older in the general population.

The all-cause mortality rate observed in patients with hip fractures was higher ($p < 0.001$) in all age groups and in both sexes when compared with all-cause age-specific mortality in the general population.

Increased mortality was most pronounced in the oldest group (≥ 85 years) of patients with hip fracture and among men in this group. The one-year standardized mortality rate was 341.3 (95% CI, 162.5–520.1) for men and 301.6 (95% CI, 212.4–391.8) for women, respectively. This implies that mortality rates in our population were 3.4 times higher for men and 3.0 times higher for woman than expected in the general population during this 1-year period. Kaplan-Meier survival decreased rapidly during the first month after hip fracture and then continued to decline, although more slowly (Fig. 1).

Patients who were not married had a lower FIM at discharge, delirium, and prosthesis dislocation, and had a higher chance of being dead 1 year after hip fracture according to the Cox proportional hazard univariate regression analysis. Motor FIM score at discharge was the only variable independently related to 1-year mortality after hip fracture in the adjusted final multivariate Cox analysis. The strength of the final multivarite model was tested with the −2 log likelihood (−2 log likelihood = 472.21, chi square = 120.89, df = 3, $p < 0.001$) (Table 3).

Discussion

The ability to predict ultimate functional recovery early in the course of hip fracture treatment would be useful in testing rehabilitation programs and surgical interventions. In this study, we found that numerous preinjury factors predicted discharge motor FIM scores, that patients with a hip fracture have an increased risk of death at 1 year compared with the general population, and that lower FIM scores at discharge predicted 1-year mortality after hip fracture.

Table 2. Variables significantly associated with FIM score

Predictors	Univariate analysis		Multivariate analysis			
			Subgroup		Final	
	RR (95% CI)	p value	RR (95% CI)	p value	RR (95% CI)	p value
Age	−0.58 (−1.67–1.16)	< 0.001	−0.53 (−1.57–1.02)	< 0.001	−0.34 (−1.06–0.58)	< 0.001
Sex	−0.04 (−7.63–4.10)	0.554				
Marital status	−0.33 (−17.48–7.99)	< 0.001	−0.14 (−9.69–1.02)	0.016	−0.08 (−6.76–0.40)	0.081
Preinjury residence	0.12 (−0.27–9.03)	0.065				
ASA	−0.15 (−10.38–0.88)	0.020	−0.15 (−10.38–.88)	0.020	−0.12 (−5.53–0.85)	0.008
SPMSQ	0.62 (3.03–4.27)	< 0.001	0.62 (3.03–4.27)	< 0.001	0.34 (1.34–2.64)	< 0.001
Motor FIM before injury	0.44 (0.57–0.98)	< 0.001	0.44 (.57–.98)	< 0.001	0.18 (0.15–0.49)	< 0.001
Type of fracture	−0.03 (−5.84–3.75)	0.669				
Waiting time for surgery	−0.11 (−13.90–0.97)	0.088				
Type of surgical procedure	−0.03 (12.72–10.39)	0.843				
Type of anesthesia	0.16 (0.95–10.31)	0.019	0.16 (.95–10.31)	0.019	0.07 (−0.57–5.64)	.109
Pressure sores	−00.37 (−23.25–11.57)	< 0.001	−0.33 (−21.55–10.23)	< 0.001	−0.11 (−9.60–0.85)	0.019
Delirium	−0.30 (−21.96–8.94)	< 0.001	−0.27 (−20.32–8.17)	< 0.001	−0.03 (−6.60–3.30)	0.512
Urinary tract infection	−0.05 (−17.56–7.80)	0.449				
Pulmonary embolism	0.01 (−23.25–26.86)	0.887				
Deep wound infection	0.03 (−19.71–30.39)	0.675				
Pneumonia	−0.07 (−38.32–11.67)	0.295				
Prosthesis dislocation	−0.11 (−23.33–1.91)	0.096				
Length of hospital stay	−0.15 (−0.62–0.05)	0.022	−0.09 (−0.46–.06)	0.133		

FIM = Functional Independence Measure; RR = relative risk; ASA = American Society of Anesthesiologists; SPMSQ = Short Portable Mental Level Questionnaire.

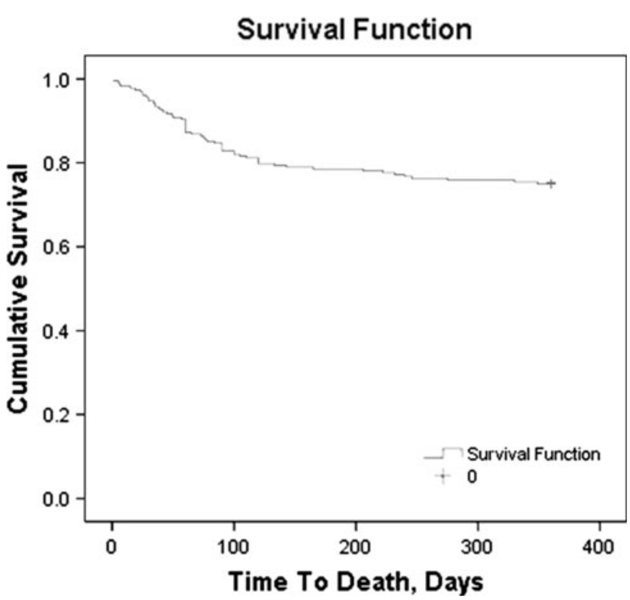

Fig. 1 The Kaplan-Meier survival curve shows 1-year mortality after fracture.

There are numerous limitations in our study. First, we excluded all patients whose total LOS exceeded 30 days to obtain a uniform study group. LOS is a variable that is in our setting influenced by different organizational factors, for example the time needed to provide health status evaluation by different specialists and the availability of beds in the postacute rehabilitation setting. A variable LOS in our patients implies that some achieved more physiotherapy sessions than others before discharge, which possibly would imply a better motor FIM score at discharge. Despite this, LOS was not independently related to motor FIM at discharge nor 1-year mortality in our patients. A motor-FIM score evaluated at the end of a rehabilitation program would be a more reliable outcome measure, but in our setting this would be a midterm functional outcome measure. However, we have taken into account the affect of waiting time for surgery on observed outcomes, because the influence of this variable has been documented in the literature [2]. The inclusion of this variable in the prediction models was of even more importance in our study, because most of our patients (89%) had an operative delay of more than 48 hours from the time of admission. Typical reasons for operative delay for our patients were unavailability of the operating room and investigation of the patient's acute or chronic comorbidities. Prolonged waiting time for surgery has been reported to lead to increased mortality, complication rates,

Table 3. Variables significantly associated with 1-year mortality

Predictors	Univariate analysis		Multivariate analysis			
			Subgroup		Final	
	HR (95% CI)	p value	HR (95% CI)	p value	HR (95% CI)	p value
Age	1.12 (1.07–1.16)	< 0.001	1.11 (1.07–1.16)	< 0.001	1.00 (0.96–1.05)	0.892
Sex	0.68 (0.37–1.25)	0.217				
Marital status	2.11 (1.09–4.07)	0.026	1.12 (0.55–2.26)	0.754		
Preinjury residence	0.82 (0.50–1.36)	0.438				
ASA	1.16 (0.69–1.96)	0.581				
SPMSQ	0.74 (0.69–0.80)	< 0.001	0.74 (0.69–0.80)	< 0.001	0.99 (0.88–1.10)	0.801
Motor FIM before injury	0.96 (0.95–0.98)	< 0.001	0.96 (0.95–0.98)	< 0.001	1.02 (0.99–1.04)	0.168
Type of fracture	0.82 (0.47–1.41)	0.464				
Waiting time for surgery	1.74 (0.63–4.80)	0.287				
Type of surgical procedure	0.89 (0.52–1.53)	0.673				
Type of anesthesia	0.69 (0.40–1.18)	0.172				
FIM discharge	0.89 (0.87–0.92)	< 0.001	0.89 (0.87–0.92)	< 0.001	0.89 (0.87–0.93)	< 0.001
Pressure sores	3.51 (2.04–6.02)	< 0.001	2.97 (1.72–5.13)	< 0.001	1.20 (0.67–2.14)	0.535
Urinary tract infection	1.01 (0.25–4.13)	0.991				
Delirium	4.54 (2.63–7.83)	< 0.001	3.72 (2.13–6.47)	< 0.001	1.37 (0.72–2.60)	0.336
Pulmonary embolism	0.05 (0.00–5611.30)	0.612				
Deep wound infection	2.34 (0.32–16.95)	0.399				
Pneumonia	2.68 (0.37–19.39)	0.329				
Prosthesis dislocation	2.84 (1.03–7.85)	0.045	1.96 (0.70–5.47)	0.200		
Length of hospital stay	1.02 (0.98–1.05)	0.362				

HR = hazard ratio; FIM = Functional Independence Measure; ASA = American Society of Anesthesiologists; Short Portable Mental Level Questionnaire.

and prolonged LOS [29, 37, 39, 40]. It seems reasonable to assume that prolonged time to surgery negatively affects rehabilitation potential owing to prolonged requirement of narcotics and to rapid loss of strength and endurance. Our results did not reveal waiting time for surgery to be independently associated with motor FIM at discharge, nor 1-year mortality. This possibly would be different if there were a different cut-off time for surgery delay; however, this question was beyond the scope of this study. However, we found a statistically significant correlation between longer waiting time for surgery (expressed in days), decubital ulcers, and 1-year mortality, which is in line with other studies that showed that delayed surgery leads to increased mortality and complication rates [29, 37, 40]. Therefore, we support the initiatives to reduce waiting times for hip fracture surgery as one of the measures to improve local healthcare quality of patients with a hip fracture.

Second, information regarding patients with severe cognitive impairment was collected from proxies, which may limit the accuracy of some of these data. However, there is evidence in the literature confirming that patient-proxy agreement levels are acceptable [18]. Another possible limitation of our study is the inclusion of patients treated with ORIF and hemiarthroplasty, which potentially introduces some bias into the study because of the difference in the magnitude of the surgery. Our results, however, showed that no statistically significant difference exists regarding functional level at discharge, postoperative complication rate, and 1-year mortality between the two groups of patients.

Age, marital status, health status, cognitive level, functional independence before injury, and the presence of pressure sores were independently related to functional level at discharge. Other authors have confirmed the association between age [20, 21, 25, 41], marital status [15, 38], cognitive level [9, 14, 41, 42], functional level before injury [3, 22], and functional outcome and mortality after hip fracture. The ASA classification of a patient's general health is widely recognized as a reliable predictor of mortality after hip fracture [5, 33, 41]. However, its capability to predict functional outcome after hip fracture has not been extensively studied [28]. In contrast to the results of Michel et al. [28], our results showed that ASA classification is a good predictor of postoperative recovery of functional independence. Many studies have reported a relationship between postoperative delirium and pressure ulcers and poor outcome after hip fracture [4, 6, 10, 12, 23, 26, 27, 36, 43], which is in line with our results. Thirty-eight (16.7%) patients had pressure ulcers develop during the initial acute hospital stay. A high incidence of pressure ulcers in patients with hip fractures, ranging from 6.8% to 29.6%, was reported in one study [6]. Introduction of a multidisciplinary approach and adoption of clinical practice guidelines aimed at prevention, prompt recognition, and treatment of pressure ulcers in routine clinical practice seems to be a necessity in our clinical setting [15, 34].

The overall 1-year mortality rate was 25% (57 patients; 25% males and 75% females) in our study. The reported cumulative unadjusted 1-year mortality rates after hip fracture range from 5.9% to 50% after hip fracture [1]. The 10-fold difference in mortality in different studies can be explained by lack of consistency of the study designs and the statistical analyses used to determine excess mortality. The higher mortality risk compared with that of the general population and higher incidence of deaths during the first months after surgery revealed in our study are consistent with the results of other authors [1, 31].

Our findings provide evidence that prediction of outcome at an early stage is possible. Short-term functional outcome proved to be a substantial and reliable predictor of 1-year mortality after hip fracture. The relationship between functional level at discharge and functional outcome after hip fracture is well documented in the literature [7, 11, 25, 45]. However, the role of functional level at discharge in predicting mortality after hip fracture rarely has been documented [3]. Our results differ from those of Alegre-Lopez et al. [3] who were unable to confirm a relationship between functional ability at discharge and mortality. Our findings revealed that patients who were older, not married at the time of fracture, who had a lower cognitive level, had a worse health status, and were more functionally dependent before fracture achieved lower FIM scores at discharge. We therefore believe that a lower functional level at discharge is a reflection of frailty and a consequence of a predetermined lower rehabilitation potential.

Functional level at discharge is the main determinant of long-term mortality in patients with hip fracture. Motor FIM score at discharge is a reliable predictor of mortality and can be recommended for clinical use. Future studies are needed to validate if better survival might be attained by more intensive rehabilitation during the early phase after hip fracture surgery, and if a certain level of achieved motor FIM threshold could ensure survival in the most elderly patients with hip fractures. It remains a challenge to identify poor rehabilitative candidates with hip fractures in the acute setting. Recognizing predictors of poor outcome, if these predictors prove to be treatable, might enable care teams to direct additional nursing care and rehabilitation resources toward them.

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