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CLINICAL RESEARCH

Do Psychiatric Comorbidities Influence Inpatient Death, Adverse Events, and Discharge After Lower Extremity Fractures?

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Abstract

Background Psychiatric comorbidity is known to contribute to illness (the state of feeling unwell/unable to rely on one's body) and increased use of healthcare resources, but the effect on inpatient outcomes in fracture care is relatively unexplored.

Questions/purposes Our primary null hypothesis is that a concomitant diagnosis of depression, anxiety, dementia, or schizophrenia is not associated with (1) discharge to another care facility rather than home after lower extremity fractures. Secondary study questions address the associations between psychiatric comorbidity and (2) longer inpatient stay and inpatient (3) adverse events; (4) blood transfusion; and (5) mortality after lower extremity fractures.

Methods Using the National Hospital Discharge Survey database, we analyzed a total estimated number of 10,669,449 patients with lower limb fractures from 1990 to 2007. Sixty-four percent were women, and the mean ± SD age was 67 ± 22 years. The prevalence in the study population was 3.2% for depression, 1.6% for anxiety, 0.6% for schizophrenia, and 2.9% for dementia.

Results A discharge diagnosis of psychiatric comorbidity was associated with a lower rate of discharge to home after accounting for an association with greater medical comorbidity (schizophrenia: odds ratio [OR], 5.6, 95% confidence interval [CI], 5.5–5.8; dementia: OR, 1.3, 95% CI, 1.2–1.3; depression: OR, 1.2, 95% CI, 1.2–1.3; anxiety: OR, 1.04, 95% CI, 1.02–1.06). Hospital stay was longer for patients with schizophrenia and dementia but shorter in patients with depression or anxiety compared with patients without any mental disorders. Schizophrenia was associated with more in-hospital adverse events and depression and anxiety with fewer events. A diagnosis of depression was associated with blood transfusion. Psychiatric comorbidity was not associated with a higher risk of in-hospital death.

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Each author certifies that his or her institution waived approval for the human protocol for this investigation because it used an anonymous database and that all investigations were conducted in conformity with ethical principles of research.
This work was performed at the Orthopaedic Hand and Upper Extremity Service, Massachusetts General Hospital, Boston, MA, USA.

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Conclusions Optimal inpatient management of patients with lower extremity fractures should account for the influence of psychiatric comorbidities, dementia and schizophrenia in particular.

Introduction

A recent study estimated that by 2030, the worldwide number of individuals with mental disorders will double [32]. Major depression and anxiety are the most commonly diagnosed mental disorders in the general population. The current global prevalence of depression is 6% to 10% in primary care settings [32] and that of anxiety is 7.3% [3]. More than 24 million people worldwide were diagnosed with dementia in 2005 with 70% attributed to Alzheimer disease [14]. In North America, 6.4% of people older than 60 years have dementia [14]. In contrast, isolated schizophrenia is rare with a lifetime prevalence of less than 1% [29].

The impact of psychiatric comorbidity on illness, treatment outcomes, and use of healthcare resources has been studied in great detail in certain fields of medicine, predominantly cardiology and neurology [10, 17, 28, 34]. Depression has been linked to an increased mortality rate after myocardial infarction, cerebrovascular disease, and cancer [32]. Both depression and anxiety are also considered risk factors for coronary artery disease [21]. In contrast to depression and anxiety, the relationship between schizophrenia and cardiovascular morbidity and mortality is less clear [9, 21, 27]; nonetheless, patients treated for schizophrenia present an increased rate of new-onset diabetes and metabolic syndrome when compared with the general population [12, 18, 22]. In particular, effective management of chronic illnesses in patients with dementia represents a current clinical challenge [19, 43].

In orthopaedic surgery, several studies have revealed a relationship between psychiatric comorbidity and a higher fracture risk that may be mediated by lower bone density and use of antipsychotics and antidepressants [6, 23, 44]. In addition, previous research has demonstrated that depression was markedly associated with poor long-term outcomes such as increased pain intensity, pain-related disability, and stiffness after TKA and spine surgery and that it correlated strongly with magnitude of disability in patients with orthopaedic trauma [8, 15, 35].

A considerable number of patients sustaining lower limb fractures have a preexisting diagnosis of depression, anxiety, schizophrenia, or dementia [8, 23, 36], but the impact of these psychiatric comorbidities on in-hospital outcomes is incompletely understood.

This study tests the primary null hypothesis that a concomitant diagnosis of depression, anxiety, dementia, or schizophrenia is not associated with (1) discharge to another care facility rather than home after lower extremity fractures. Secondary study purposes address the associations between psychiatric comorbidity and (2) longer inpatient stay, and inpatient (3) adverse events; (4) blood transfusion; and (5) mortality after lower extremity fractures.

Patients and Methods

This study was conducted by analysis of demographic and medical information for inpatients discharged from nonfederal, short-stay hospitals in the United States. All information was obtained from the National Hospital Discharge Survey (NHDS) database, a national probability survey initiated by the National Center for Health Statistics in 1965 and collected annually since then [11]. The NHDS uses the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes for classifying medical diagnoses and procedures [4, 26]. The NHDS provides data containing up to seven diagnoses and up to four procedures besides principal demographic information. Approval of our institutional review board was not required to carry out the study, because all data were adequately deidentified and publicly available.

Using ICD-9-CM codes, we identified all adult (18 years or older) patients with a lower extremity fracture between 1990 and 2007. A fracture of the lower limb was defined as the presence of any of the following fractures (and corresponding ICD-9-CM codes): neck of femur (820.x, called "fracture of neck of femur" but also containing pertrochanteric fractures), femur other or unspecified sites (821.x), patella (822.x), tibia and fibula (823.x), ankle (824.x), and tarsal and metatarsal bones (825.x). Concomitant injuries, comorbidities, adverse events, and procedures were also based on ICD-9 codes (Appendix 1 in Electronic supplementary material). To analyze their influence on outcome, mental disorders were further divided into subgroups: depression (ICD-9-CM 296.2, 296.3, 296.5, 296.9, 300.4, 301.12, 309.0, 311.x), anxiety (ICD-9-CM 300.x, 309.24, 309.28), schizophrenia (ICD-9-CM 295.x), or dementia (ICD9-CM 290.x).

A total estimated number of 10,669,449 patients with a lower extremity fracture were included in the sample and analyzed. Sixty-four percent were women, and the mean $\pm$ SD age was 67 $\pm$ 22 years (Table 1). The most frequent fractures were femoral neck fractures in 55% of the cohort. Twelve percent of patients had multiple fractures. On average, 56% of patients had one or more medical comorbidities.

Dichotomous outcome variables were discharge to either a short- or long-term facility, presence of adverse events, need for transfusion, and mortality. The variable

Table 1. Overview: bivariate analysis of patients with a lower extremity fracture

Parameter	Total (%)	No mental disorders (%)	p value	Depression (%)	p value	Anxiety (%)	p value	Schizophrenia (%)	p value	Dementia (%)	p value
Percent of the total cohort	100	93		3.2		1.6		0.6		2.9	
Sex											
Male	36	38	< 0.001	20	< 0.001	19	< 0.001	36	0.92	21	< 0.001
Female	64	63		80		81		64		79	
Age groups (years)											
≤ 35	13	14	< 0.001	3.8	< 0.001	7.2	< 0.001	5.5	< 0.001	0.1	< 0.001
36–55	17	17		19		19		25		0.2	
56–65	8.6	8.7		10		10		14		0.4	
> 65	62	60		67		63		56		99.3	
Number of fractures											
Single fracture	88	87	< 0.001	94	< 0.001	91	< 0.001	90	< 0.001	96	< 0.001
Multiple fractures	12	13		6.1		9.5		9.9		4.3	
Fracture type											
Femoral neck	55	54	< 0.001	63	< 0.001	59	< 0.001	57	< 0.001	91	< 0.001
Femur	8.9	9.1	< 0.001	7.1	< 0.001	8.6	< 0.001	5.7	< 0.001	5.1	< 0.001
Patella	3	3.5	< 0.001	2.8	< 0.001	4.5	< 0.001	5.0	< 0.001	0.7	< 0.001
Tibia/fibula	13	13	< 0.001	9.1	< 0.001	9.2	< 0.001	15	< 0.001	1.4	< 0.001
Ankle	19	19	< 0.001	16	< 0.001	17	< 0.001	18	< 0.001	2.2	< 0.001
Tarsal/metatarsal	6	6	< 0.001	3.7	< 0.001	5.5	0.73	2.6	< 0.001	0.2	< 0.001
Comorbidities*											
No	44	45	< 0.001	29	< 0.001	32	< 0.001	39	< 0.001	29	< 0.001
Yes	56	55		71		68		62		71	
Adverse events											
No	74	74	< 0.001	76	< 0.001	75	< 0.001	70	< 0.001	67	< 0.001
Yes	27	26		24		25		31		33	
Need for transfusion											
No	90	90	< 0.001	89	< 0.001	92	< 0.001	90	0.82	86	< 0.001
Yes	10	10		11		8.3		11		14	
Discharge status											
Routine/discharged home	44	46	< 0.001	35	< 0.001	37	< 0.001	21	< 0.001	15	< 0.001
Left against medical advice	0.2	0.2		0.3		0.2		0.4		0.5	
Discharged/transferred to short-term facility	10	10		11		14		11		13	
Discharged/transferred to long-term facility	32	30		41		34		55		63	
Alive, disposition not stated	10	10		11		13		11		6.6	
Dead	2.0	2.1		0.9		0.7		0.3		2.0	
Not reported	1.7	1.8		0.9		2.0		1		0.9	

Table 1. continued

Parameter	Total (%)	No mental disorders (%)	p value	Depression (%)	p value	Anxiety (%)	p value	Schizophrenia (%)	p value	Dementia (%)	p value
Mortality	2.0	2.1	< 0.001	0.9	< 0.001	0.7	< 0.001	0.3	< 0.001	2.0	0.79
Age (years ± SD)	67 ± 22	66 ± 22	< 0.001	71 ± 17	< 0.001	68 ± 19	< 0.001	64 ± 17	< 0.001	85 ± 7.0	< 0.001
Days of care (days ± SD)	7.3 ± 8.3	7.2 ± 8.3	< 0.001	6.6 ± 6.8	< 0.001	6.6 ± 7.6	< 0.001	11 ± 21	< 0.001	7.9 ± 7.1	< 0.001

* Other than mental disorders.

discharge contained only information from 2001 to 2007, because these data were not collected before 2001. Patients' characteristics among subgroups and outcomes were compared using a chi-square test for categorical data and independent-samples t-tests for continuous data while assuming normality based on the large sample size. To investigate whether depression, anxiety, schizophrenia, or dementia was an independent predictor of a negative outcome (discharge to rehabilitation facility, adverse event, blood transfusion, mortality) while accounting for important cofactors such as sex, age, and medical comorbidities, we entered all variables present in at least 2% of the population [24] into a logistic regression model; for complications, as a result of their lower rates, we used a 1% cutoff value. The adoption of multivariable regression models allowed us to control for potential confounders and isolate the effect of psychiatric comorbidities on inpatient outcomes. Adjusted odds ratio and confidence intervals were calculated to assess the association between psychiatric comorbidities and inpatient outcomes. Based on the large number of comparisons, a p value of < 0.001 was considered statistically significant in all analyses. For statistical analyses and data modeling, SPSS Version 16.0 (SPSS, Chicago, IL) was used.

In the NHDS population evaluated, the prevalence for mental disorders was 3.2% for depression, 1.6% for anxiety, 0.6% for schizophrenia, and 2.9% for dementia. Patients with depression, anxiety, and dementia were predominantly women and older compared with patients without these diagnoses ($p < 0.001$) (Table 1). Patients with mental illness had higher rates of medical comorbidities (Table 2). Particularly, patients with either depression or dementia presented with the highest rate of comorbidities: 71% of them had at least one comorbidity. Hypertensive disease (27%), chronic pulmonary disease (12%), and chronic coronary artery disease (11%) were the most frequent comorbidities.

Results

Patients with any of the four mental disorders were discharged home at a lower percentage (depression: 35%, anxiety: 37%, schizophrenia: 21%, dementia: 15%) than individuals without mental illnesses (46%) (Table 1). Sixty-three percent of all patients with dementia were transferred to a long-term facility after hospital discharge followed by patients with schizophrenia (55%), depression (41%), and anxiety (34%). Patients with anxiety presented the highest tendency of being transferred to a short-term facility (14%). After accounting for potential confounding factors, multivariable logistic regression models showed increased odds for discharge to a facility in all patients with any of the four mental disorders compared with patients

Table 2. Comorbidities: bivariate analysis of patients with a lower extremity fracture

Parameter	Total (%)	No mental disorders (%)	p value	Depression (%)	p value	Anxiety (%)	p value	Schizophrenia (%)	p value	Dementia (%)	p value
Hypertensive disease	27	26	< 0.001	41	< 0.001	44	< 0.001	22	< 0.001	31	< 0.001
Diabetes mellitus	9.3	9.3	< 0.001	11	< 0.001	8.5	< 0.001	12	< 0.001	9.8	< 0.001
Obesity	1.3	1.3	< 0.001	2.5	< 0.001	2.0	< 0.001	2.2	< 0.001	0.0	< 0.001
Chronic pulmonary disease	12	11	< 0.001	15	< 0.001	15	< 0.001	79	< 0.001	10	< 0.001
Moderate to severe renal disease	1.3	1.3	< 0.001	0.6	< 0.001	0.3	< 0.001	1.9	< 0.001	0.9	< 0.001
Mild liver disease	0.4	0.4	< 0.001	0.3	0.001	0.5	< 0.001	0.2	< 0.001	0.3	< 0.001
Moderate to severe liver disease	0.1	0.1	< 0.001	0.1	< 0.001	0.0	0.002	0.1	0.66	0.0	< 0.001
Myocardial infarction	2.1	2.2	< 0.001	1.6	< 0.001	2.4	< 0.001	0.4	< 0.001	1.9	< 0.001
Chronic coronary artery disease	11	11	< 0.001	12	< 0.001	11	< 0.001	5	< 0.001	14	< 0.001
Atrial fibrillation	7.6	7.7	< 0.001	4.5	< 0.001	3.2	< 0.001	4.8	< 0.001	9.8	< 0.001
Congestive heart failure	8.5	8.6	< 0.001	5.5	< 0.001	5	< 0.001	5.6	< 0.001	11.4	< 0.001
Peripheral vascular disease	1.2	1.3	< 0.001	1.1	< 0.001	1.2	0.042	2.4	< 0.001	0.8	< 0.001
Cerebrovascular disease	3.4	3.2	< 0.001	2.2	< 0.001	2.0	< 0.001	0.5	< 0.001	11	< 0.001
Chronic alcoholism	1.0	1.0	< 0.001	1.5	< 0.001	2.3	< 0.001	3.2	< 0.001	0.2	< 0.001
Nutrional deficiency	1.5	1.5	< 0.001	0.7	< 0.001	0.8	< 0.001	1.0	< 0.001	2.0	< 0.001
Osteoporosis	5.8	5.5	< 0.001	9.5	< 0.001	9.1	< 0.001	4.3	< 0.001	8.6	< 0.001
Thyroid disease	5.6	5.3	< 0.001	12	< 0.001	10	< 0.001	6.7	< 0.001	5.5	0.77
Connective tissue disease	1.4	1.5	< 0.001	1.9	< 0.001	2.1	< 0.001	0.0	< 0.001	0.4	< 0.001
Ulcer disease	0.7	0.6	< 0.001	1.2	< 0.001	1.1	< 0.001	0.5	< 0.001	0.9	< 0.001
Hemiplegia	0.8	0.8	< 0.001	1.0	< 0.001	0.2	< 0.001	0.1	< 0.001	1.6	< 0.001
AIDS	0.1	0.1	0.015	0.1	< 0.001	0.0	< 0.001	0.4	< 0.001	0.0	< 0.001
Any tumor	1.2	1.2	< 0.001	1.0	< 0.001	1.2	0.048	1.3	0.26	1.4	< 0.001
Leukemia	0.3	0.3	< 0.001	0.1	< 0.001	0.2	< 0.001	0.1	< 0.001	0.1	< 0.001
Lymphoma	0.3	0.3	< 0.001	0.3	< 0.001	0.1	< 0.001	0.0	< 0.001	0.0	< 0.001
Metastatic solid tumor	0.7	0.7	< 0.001	0.5	< 0.001	0.5	< 0.001	0.2	< 0.001	0.4	< 0.001

without these diagnoses (schizophrenia: odds ratio [OR], 5.6, 95% confidence interval [CI], 5.5–5.8, $p < 0.001$; dementia: OR, 1.3, 95% CI, 1.2–1.3, $p < 0.001$; depression: OR, 1.2, 95% CI, 1.2–1.3, $p < 0.001$; anxiety: OR, 1.04, 95% CI, 1.02–1.06, $p < 0.001$) (Table 3).

Patients with either depression or anxiety stayed significantly less time in the hospital (6.6 ± 6.8 and 6.6 ± 7.6 days, respectively) compared with patients without any mental disorders (7.2 ± 8.3 days) ($p < 0.001$) (Table 1). On the other hand, patients with schizophrenia or dementia were hospitalized longer (11 ± 21 and 7.9 ± 7.1 days, respectively) ($p < 0.001$).

Patients without a mental disorder were less likely to have adverse events (OR, 0.9; 95% CI, 0.89–0.90; $p < 0.001$) compared with patients with mental disorders (Table 4). Acute posthemorrhagic anemia was the most often encountered adverse event (12% of the patients) (Table 5). Patients with schizophrenia (31%) and dementia (33%) had more adverse events and patients with depression (24%) and anxiety (25%) had fewer adverse events compared with patients without these diagnoses (26%). Those with either schizophrenia or dementia were mostly affected by pulmonary complications and acute postoperative anemia. The ORs for adverse events were significantly higher in patients with schizophrenia (OR, 1.2; 95% CI, 1.2–1.3; $p < 0.001$). Anxiety had no significant effect on complications. On the other hand, both depression and dementia (while controlling for all other variables) were

Table 3. Predictors of discharge to facility after lower extremity fracture*

Parameter	Significance	OR	95% CI	
			Lower	Upper
Schizophrenia	< 0.001	5.6	5.5	5.8
Fracture of femur (other than neck)	< 0.001	3.5	3.5	3.6
Fracture of neck of femur	< 0.001	3.2	3.1	3.2
Cerebrovascular disease	< 0.001	2.5	2.4	2.5
Pulmonary insufficiency	< 0.001	2.5	2.4	2.5
Chest or abdominal trauma	< 0.001	2.3	2.3	2.4
Fracture of tibia and fibula	< 0.001	2.2	2.2	2.2
Partial hip arthroplasty	< 0.001	2.1	2.1	2.1
Fracture of neck and trunk	< 0.001	2.0	2.0	2.1
Acute renal failure	< 0.001	1.9	1.8	1.9
Congestive heart failure	< 0.001	1.7	1.7	1.7
Induced mental disorder	< 0.001	1.6	1.5	1.6
Pneumonia pulmonary congestion	< 0.001	1.5	1.5	1.6
Chronic pulmonary disease	< 0.001	1.5	1.5	1.5
Fracture of radius and ulna	< 0.001	1.5	1.5	1.5
Diabetes mellitus	< 0.001	1.5	1.4	1.5
Transfusion	< 0.001	1.4	1.4	1.5
Acute postoperative anemia	< 0.001	1.4	1.4	1.4
Fracture of tarsal or metatarsal bones	< 0.001	1.4	1.4	1.4
Complications not elsewhere classified	< 0.001	1.4	1.4	1.4
Geographic Northeast compared with South	< 0.001	1.4	1.4	1.4
Atrial fibrillation	< 0.001	1.4	1.3	1.4
Thyroid disease	< 0.001	1.4	1.3	1.4
Geographic Midwest compared with South	< 0.001	1.3	1.3	1.3
CRIF	< 0.001	1.3	1.3	1.3
Chronic coronary artery disease	< 0.001	1.3	1.3	1.3
Male sex	< 0.001	1.3	1.3	1.3
Dementia	< 0.001	1.3	1.2	1.3
Geographic West compared with South	< 0.001	1.2	1.2	1.3
ORIF	< 0.001	1.2	1.2	1.2
Depression	< 0.001	1.2	1.2	1.2
Wound complication	< 0.001	1.1	1.1	1.2
Fracture of ankle	< 0.001	1.1	1.1	1.1
Fracture of patella	< 0.001	1.1	1.1	1.1
Osteoporosis	< 0.001	1.1	1.1	1.1
Age	< 0.001	1.1	1.1	1.1
Hypertension	< 0.001	1.1	1.1	1.1
Anxiety	< 0.001	1.04	1.02	1.06
Myocardial infarction	< 0.001	1.03	1.01	1.06
Days of care	< 0.001	0.997	0.997	0.998
Number of beds 200–299 compared with 6–99	< 0.001	0.98	0.97	0.98
Number of beds 100–199 compared with 6–99	< 0.001	0.92	0.91	0.93
Number of beds 300–499 compared with 6–99	< 0.001	0.83	0.82	0.84
Number of beds > 500 compared with 6–99	< 0.001	0.72	0.71	0.73

* From bivariate analyses' significant variables in the model: age, sex, geographic region, hospital size, days of care, fracture of neck or trunk, fracture of radius/ulna, fracture of femur neck, fracture of femur other than neck, fracture of patella, fracture of tibia/fibula, fracture of ankle, fracture of tarsal/metatarsal, chest or abdominal trauma, depression, anxiety, dementia, schizophrenia, hypertensive disease, chronic coronary artery disease, atrial fibrillation, osteoporosis, thyroid disease, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes, wound complication, acute renal failure, complications not elsewhere classified, acute posthemorrhagic anemia, induced mental disorders, transfusion, pneumonia or pulmonary congestion, pulmonary insufficiency, CRIF, ORIF, partial hip arthroplasty; OR = odds ratio; CI = confidence interval; ORIF = open reduction and internal fixation; CRIF = closed reduction and internal fixation.

Table 4. Predictors of adverse events after lower extremity fracture*

Parameter	Significance	OR	95% CI	
			Lower	Upper
Fracture of femur (other than neck)	< 0.001	3.4	3.4	3.5
Fracture of neck of femur	< 0.001	3.2	3.2	3.2
Myocardial infarction	< 0.001	2.7	2.7	2.7
Chest or abdominal trauma	< 0.001	2.5	2.5	2.6
ORIF	< 0.001	2.3	2.3	2.3
Partial hip arthroplasty	< 0.001	2.2	2.1	2.2
CRIF	< 0.001	2.1	2.0	2.1
Head trauma	< 0.001	1.8	1.8	1.8
Fracture of tibia and fibula	< 0.001	1.4	1.4	1.4
Congestive heart failure	< 0.001	1.4	1.4	1.4
Fracture of neck and trunk	< 0.001	1.3	1.3	1.3
Schizophrenia	< 0.001	1.2	1.2	1.3
Atrial fibrillation	< 0.001	1.2	1.2	1.2
Geographic West compared with South	< 0.001	1.2	1.2	1.2
Chronic pulmonary disease	< 0.001	1.1	1.1	1.1
Geographic Midwest compared with South	< 0.001	1.1	1.1	1.1
Days of care	< 0.001	1.03	1.03	1.03
Age	< 0.001	1.02	1.02	1.02
Osteoporosis	< 0.001	1.01	1.01	1.02
Male sex	< 0.001	1.01	1.003	1.01
Geographic Northeast compared with South	< 0.001	1.01	1.01	1.02
Cerebrovascular disease	< 0.001	0.98	0.97	0.98
Hypertension	< 0.001	0.97	0.97	0.97
Diabetes mellitus	< 0.001	0.95	0.94	0.95
Number of beds > 500 compared with 6–99	< 0.001	0.91	0.91	0.92
Number of beds 300–499 compared with 6–99	< 0.001	0.90	0.90	0.91
Number of beds 100–199 compared with 6–99	< 0.001	0.88	0.88	0.89
Number of beds 200–299 compared with 6–99	< 0.001	0.87	0.86	0.87
Thyroid disease	< 0.001	0.86	0.86	0.87
Depression	< 0.001	0.86	0.85	0.86
Fracture of radius and ulna	< 0.001	0.84	0.84	0.85
Fracture of tarsal or metatarsal bones	< 0.001	0.75	0.74	0.75
Dementia	< 0.001	0.74	0.74	0.75
Fracture of patella	< 0.001	0.70	0.70	0.71
Chronic coronary artery disease	< 0.001	0.69	0.69	0.70
Fracture of ankle	< 0.001	0.59	0.58	0.59

* From bivariate analyses' significant variables in the model: age, sex, geographic region, hospital size, days of care, fracture of neck or trunk, fracture of radius/ulna, fracture of femur neck, fracture of femur other than neck, fracture of patella, fracture of tibia/fibula, fracture of ankle, fracture of tarsal/metatarsal, head trauma, chest or abdominal trauma, depression, anxiety, schizophrenia, dementia, hypertensive disease, chronic coronary artery disease, atrial fibrillation, osteoporosis, thyroid disease, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes, CRIF, ORIF, partial hip arthroplasty; OR = odds ratio; CI = confidence interval; ORIF = open reduction and internal fixation; CRIF = closed reduction and internal fixation.

associated with significantly lower odds for adverse events (depression: OR, 0.86, 95% CI, 0.85–0.86, $p < 0.001$; dementia: OR, 0.74, 95% CI, 0.74–0.75, $p < 0.001$).

Fourteen percent of patients with depression had blood transfusions during the inpatient period. Depression was the only mental disorder with an increased risk for blood transfusion (OR, 1.1; 95% CI, 1.1–1.1, $p < 0.001$) (Table 6).

With regard to in-hospital mortality, patients with any of the four psychiatric comorbidities exhibited a decreased rate of

Table 5. Adverse events: bivariate analysis of patients with a lower extremity fracture

Parameter	Total (%)	No mental disorders (%)	p value	Depression (%)	p value	Anxiety (%)	p value	Schizophrenia (%)	p value	Dementia (%)	p value
Surgery-related complications											
Wound complications	1.3	1.3	0.01	0.8	< 0.001	1.5	< 0.001	2.2	< 0.001	1.4	0.012
Acute posthemorrhagic anemia	12	12	< 0.001	12	< 0.001	13	< 0.001	16	< 0.001	19	< 0.001
General complications											
Complications not elsewhere classified	3.3	3.5	< 0.001	1.1	< 0.001	1.2	< 0.001	2.1	< 0.001	2.3	< 0.001
Acute renal failure	0.9	1.0	< 0.001	0.2	< 0.001	0.3	< 0.001	1.2	< 0.001	0.2	< 0.001
Acute myocardial infarct	0.8	0.8	< 0.001	0.2	< 0.001	0.1	< 0.001	0.1	< 0.001	0.7	0.060
Ventricular arrhythmias and arrest	0.3	0.3	< 0.001	0.1	< 0.001	0.2	< 0.001	0.1	< 0.001	0.3	0.37
Iatrogenic hypotension	0.1	0.1	< 0.001	0.1	< 0.001	0.1	0.013	0.0	< 0.001	0.0	< 0.001
Pulmonary embolism	0.4	0.4	< 0.001	0.5	< 0.001	0.1	< 0.001	0.1	< 0.001	0.3	< 0.001
Fat embolism	0.1	0.2	< 0.001	0.0	< 0.001	0.0	< 0.001	0.0	< 0.001	0.0	< 0.001
Induced mental disorder	1.4	1.4	< 0.001	2.1	< 0.001	1.6	< 0.001	0.9	< 0.001	0.6	< 0.001
Pneumonia, pulmonary congestion	2.4	2.4	0.013	1.2	< 0.001	1.9	< 0.001	4.7	< 0.001	3.1	< 0.001
Pulmonary insufficiency	1.2	1.3	< 0.001	0.4	< 0.001	1.1	0.001	0.5	< 0.001	0.2	< 0.001
Deep venous thrombosis	0.6	0.6	< 0.001	1.2	< 0.001	0.4	< 0.001	1.2	< 0.001	0.1	< 0.001
Intubation or mechanical ventilation	1.1	1.2	< 0.001	0.2	< 0.001	0.3	< 0.001	0.1	< 0.001	0.2	< 0.001
Transfusion of blood	10	10	< 0.001	11	< 0.001	8.3	< 0.001	11	0.82	14	< 0.001
Conversion of cardiac rhythm	0.2	0.2	< 0.001	0.1	< 0.001	0.1	< 0.001	0.0	< 0.001	0.4	< 0.001

mortality compared with individuals without these conditions (depression: 0.9%; anxiety: 0.7%; schizophrenia: 0.3%; dementia: 2%; those without these diagnoses: 2.1%). No mental illness was associated with a higher risk of in-hospital mortality. In particular, the presence of schizophrenia had the lowest odds for in-hospital death (OR, 0.17; 95% CI, 0.15–0.20; $p < 0.001$) (Table 7).

Discussion

Psychiatric comorbidity is a considerable cause of disability and high healthcare resource use. Although there has been a substantial increase in the prevalence of mental disorders, there is a paucity of nationally representative information on discharge disposition and inpatient outcomes in patients with psychiatric comorbidity sustaining lower extremity fractures. We analyzed the influence of concomitant depression, anxiety, dementia, or schizophrenia on discharge to home, longer inpatient stay and in-hospital adverse events, blood transfusion, and death after lower extremity fractures.

Our results should be interpreted in light of several limitations, most a consequence of the analysis of data from administrative databases [25]. First, all diagnoses, procedures, and adverse events were retrieved using the ICD-9 codes. Given the large sample size of our study, we cannot neglect the possibility of misclassification of the codes examined in this study. However, misclassification errors tend to occur in similar frequency in all comparison groups in large-scale studies [39]. Second, it is impossible to determine when diagnoses predate the admission and when they are new.

Table 6. Predictors of blood transfusion after lower extremity fracture*

Parameter	Significance	OR	95% CI	
			Lower	Upper
Fracture of femur (other than neck)	< 0.001	3.2	3.1	3.2
Acute posthemorragic anemia	< 0.001	3.0	3.0	3.0
ORIF	< 0.001	2.8	2.8	2.8
CRIF	< 0.001	2.6	2.6	2.7
Partial hip arthroplasty	< 0.001	2.4	2.4	2.4
Fracture of neck of femur	< 0.001	2.3	2.3	2.4
Congestive heart failure	< 0.001	1.4	1.4	1.4
Atrial fibrillation	< 0.001	1.4	1.4	1.4
Chest or abdominal trauma	< 0.001	1.4	1.3	1.4
Wound complication	< 0.001	1.3	1.3	1.4
Pneumonia pulmonary congestion	< 0.001	1.3	1.3	1.3
Number of beds > 500 compared with 6–99	< 0.001	1.3	1.3	1.3
Hypertension	< 0.001	1.3	1.3	1.3
Osteoporosis	< 0.001	1.2	1.2	1.2
Diabetes mellitus	< 0.001	1.2	1.2	1.2
Head trauma	< 0.001	1.2	1.2	1.2
Chronic pulmonary disease	< 0.001	1.2	1.2	1.2
Number of beds 200–299 compared with 6–99	< 0.001	1.1	1.1	1.1
Male sex	< 0.001	1.1	1.1	1.1
Cerebrovascular disease	< 0.001	1.1	1.1	1.1
Numberof beds 300–499 compared with 6–99	< 0.001	1.1	1.1	1.1
Depression	< 0.001	1.1	1.1	1.1
Thyroid disease	< 0.001	1.1	1.1	1.1
Induced mental disorder	< 0.001	1.1	1.0	1.1
Geographic West compared with South	< 0.001	1.05	1.04	1.1
Fracture of neck and trunk	< 0.001	1.04	1.03	1.1
Number of beds 100–199 compared with 6–99	< 0.001	1.03	1.02	1.03
Age	< 0.001	1.02	1.02	1.02
Days of care	< 0.001	0.996	0.996	0.997
Complications not elsewhere classified	0.024	0.99	0.98	0.999
Chronic coronary artery disease	< 0.001	0.99	0.98	0.99
Pulmonary insufficiency	0.001	0.97	0.95	0.99
Geographic Northeast compared with South	< 0.001	0.91	0.91	0.92
Fracture of tibia and fibula	< 0.001	0.85	0.84	0.87
Dementia	< 0.001	0.78	0.77	0.79
Fracture of radius and ulna	< 0.001	0.71	0.70	0.72
Anxiety	< 0.001	0.70	0.69	0.72
Fracture of tarsal or metatarsal bones	< 0.001	0.65	0.64	0.67
Geographic Midwest compared with South	< 0.001	0.55	0.55	0.55
Fracture of ankle	< 0.001	0.43	0.42	0.43
Fracture of patella	< 0.001	0.37	0.36	0.38

* From bivariate analyses' significant variables in the model: age, sex, geographic region, hospital size, days of care, fracture of neck or trunk, fracture of radius/ulna, fracture of femur neck, fracture of femur other than neck, fracture of patella, fracture of tibia/fibula, fracture of ankle, fracture of tarsal/metatarsal, head trauma, chest or abdominal trauma, depression, anxiety, dementia, hypertensive disease, chronic coronary artery disease, atrial fibrillation, osteoporosis, thyroid disease, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes, wound complication, complications not elsewhere classified, acute posthemorrhagic anemia, induced mental disorders, pneumonia or pulmonary congestion, pulmonary insufficiency, CRIF, ORIF, partial hip arthroplasty; OR = odds ratio; CI = confidence interval; ORIF = open reduction and internal fixation; CRIF = closed reduction and internal fixation.

Table 7. Predictors of mortality after lower extremity fracture*

Parameter	Significance	OR	95% CI	
			Lower	Upper
Pulmonary insufficiency	< 0.001	12	11	12
Head trauma	< 0.001	4.2	4.1	4.3
Myocardial infarction	< 0.001	4.2	4.1	4.2
Chest or abdominal trauma	< 0.001	4.1	4.0	4.2
Fracture of femur (other than neck)	< 0.001	3.6	3.5	3.7
Complications not elsewhere classified	< 0.001	3.0	2.9	3.0
Fracture of neck of femur	< 0.001	3.0	2.9	3.1
Pneumonia pulmonary congestion	< 0.001	2.9	2.9	3.0
Congestive heart failure	< 0.001	2.1	2.1	2.2
Fracture of neck and trunk	< 0.001	2.1	2.1	2.2
Cerebrovascular disease	< 0.001	1.9	1.9	1.9
Fracture of tibia and fibula	< 0.001	1.8	1.8	1.9
Atrial fibrillation	< 0.001	1.8	1.8	1.8
Chronic pulmonary disease	< 0.001	1.4	1.4	1.4
Male sex	< 0.001	1.4	1.4	1.4
Transfusion	< 0.001	1.3	1.2	1.3
Age	< 0.001	1.04	1.04	1.04
Days of care	< 0.001	0.97	0.97	0.97
Geographic Northeast compared with South	< 0.001	0.94	0.93	0.95
Geographic Midwest compared with South	< 0.001	0.91	0.90	0.92
Acute posthemorragic anemia	< 0.001	0.85	0.84	0.87
Fracture of patella	< 0.001	0.81	0.77	0.85
Number of beds 100–199 compared with 6–99	< 0.001	0.78	0.77	0.79
Chronic coronary artery disease	< 0.001	0.78	0.77	0.79
Numberof beds 300–499 compared with 6–99	< 0.001	0.77	0.76	0.78
Number of beds > 500 compared with 6–99	< 0.001	0.76	0.75	0.78
Fracture of radius and ulna	< 0.001	0.75	0.73	0.78
Depression	< 0.001	0.69	0.67	0.72
Anxiety	< 0.001	0.68	0.64	0.72
Osteoporosis	< 0.001	0.68	0.66	0.70
Fracture of ankle	< 0.001	0.62	0.60	0.64
Hypertension	< 0.001	0.59	0.58	0.60
Diabetes mellitus	< 0.001	0.58	0.57	0.60
Thyroid disease	< 0.001	0.55	0.54	0.57
ORIF	< 0.001	0.51	0.50	0.51
Partial hip arthroplasty	< 0.001	0.51	0.51	0.52
Fracture of tarsal or metatarsal bones	< 0.001	0.43	0.40	0.45
CRIF	< 0.001	0.41	0.40	0.42
Induced mental disorder	< 0.001	0.21	0.19	0.22
Schizophrenia	< 0.001	0.17	0.15	0.20

* From bivariate analyses' significant variables in the model: age, sex, geographic region, hospital size, days of care, fracture of neck or trunk, fracture of radius/ulna, fracture of femur neck, fracture of femur other than neck, fracture of patella, fracture of tibia/fibula, fracture of ankle, fracture of tarsal/metatarsal, head trauma, chest or abdominal trauma, depression, anxiety, schizophrenia, hypertensive disease, chronic coronary artery disease, atrial fibrillation, osteoporosis, thyroid disease, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes, wound complication, complications not elsewhere classified, acute posthemorrhagic anemia, induced mental disorders, transfusion, pneumonia or pulmonary congestion, pulmonary insufficiency, CRIF, ORIF, partial hip arthroplasty; OR = odds ratio; CI = confidence interval; ORIF = open reduction and internal fixation; CRIF = closed reduction and internal fixation.

Third, the maximum number of listed diagnoses in the NHDS database is seven, which might underestimate medical conditions such as chronic stable mental disorders. Fourth, administrative databases tend to underreport psychiatric diagnoses by orthopaedic surgeons when using administrative databases, which may be the case for our study given that the prevalence of psychiatric diagnosis in our study population was only 3.2%, whereas the prevalence in the US population is approximately 10% [2, 32, 37]. Fifth, specific data such as medication use were not at our disposal; therefore, we had no evidence of adequate treatment of concurrent psychiatric disorders before hospital admission. Sixth, outpatient data were not available; therefore, information regarding adverse events and mortality rates after hospital discharge as well as readmission rates remains undetected. Finally, the large sample size of this study might identify statistically significant differences that are not clinically relevant or reproducible. Along these lines, it is recognized that the effect sizes for many of the significant findings were very small and potentially irrelevant or irreproducible.

We found that the presence of any of the four analyzed mental disorders increased the risk for discharge to inpatient rehabilitation facilities after lower limb fractures. Schizophrenia was the strongest risk factor for nonroutine discharge. These results were consistent with those of previous studies suggesting that concomitant psychiatric and affective disorders in patients with orthopaedic disorders were independent risk factors for increased healthcare resource use [40, 41].

Schizophrenia was deemed an independent risk factor for in-hospital adverse events, including acute renal failure, pneumonia, and deep venous thrombosis. As to schizophrenia and its association with more in-hospital adverse events, analogous findings were reported in hip arthroplasty [33] and general surgery procedures [7]. It is possible that social isolation and communication difficulties could contribute to adverse events in patients with schizophrenia. Contrary to the study conducted by Hu et al. [20], our study showed no increased risk for adverse events in demented patients, perhaps related to the use of different statistical approaches. Hu et al. [20] conducted a retrospective case-control study, in which patients with dementia, known to have a higher comorbidity burden, were compared with sex- and age-matched nondemented control subjects [20]. They only included patients after major surgery. It may be that in our cohort the patients with dementia had less frequent and less invasive surgery or even nonoperative treatment. Their statistical techniques did not account for greater comorbidities among demented patients. Patients with depression were hospitalized nearly 1 day shorter than the other patients, which is different from some prior studies [15, 35]. Given the small effect size, this finding may be spurious.

Depression was the only psychiatric disorder associated with higher odds for blood transfusion, but again, the effect size was small. It is possible that symptoms characteristic of depression such as fatigue and diminished appetite may be misinterpreted by physicians as symptoms of anemia, thus subsequently leading to a higher perioperative administration of blood products [16, 31].

No psychiatric disorders were associated with an increased risk of in-hospital death in our cohort. Particularly, schizophrenia, depression, and anxiety showed significantly lower odds. These inferences, along with the inverse relationship between adverse events with depression and dementia, may seem puzzling at first given the augmented comorbidity burden and increased healthcare resource use of psychiatric patients. One hypothetical way of explaining the paradoxical decreased rate in mortality and short-term adverse events among mentally ill patients is that they may be more inclined, compared with the general population, to estimate bodily sensations and changes as indicators of a catastrophic illness [42]. Additionally, hypochondriasis is more common in patients with psychiatric disorders, especially depression [13]. This underlying fear of illness may trigger a "pain alarm," thus leading to both higher levels of attention by healthcare professionals and an increased use of resources [38]. In other words, depressed and anxious inpatients may feel less well for a given pathophysiology—ie, they may have less disease than the average inpatient with a similar illness. Furthermore, the challenges some clinicians may encounter while treating patients with mental disorders, with perhaps lower self-efficacy for managing pain and other symptoms, and less resiliency in maintaining function [30], might contribute to a higher rate of discharge to rehabilitation facilities. In line with our findings, a recent study found that dementia was the only independent risk factors for 90-day postoperative mortality after TKA [5]. Contrary to our findings, Abrams et al. [1] found a slightly increased risk of 30-day death rates among postsurgical patients with psychiatric disorders; however, both the study population and the study design were different. Their sample consisted of veterans, and they linked inpatient and outpatient databases to identify the effect of psychiatric comorbidities on mortality.

We found that concomitant psychiatric disorders among trauma patients were risk factors for discharge to a rehabilitation facility rather than home. On the other hand, in-hospital adverse events and mortality rates were lower than in patients with psychiatric comorbidity with the exception of schizophrenia. Further research should investigate causes for the increased nonroutine discharge in psychiatric patients and its impact on overall healthcare costs. Optimal inpatient management and posthospital care of patients with lower extremity fractures might improve

by accounting for the influence of psychiatric comorbidities, dementia and schizophrenia in particular.

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