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Research Article

Risk Factors for In-Hospital Complications of Fall-Related Fractures among Older Chinese: A Retrospective Study

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Purpose. The aim of this study was to investigate the risk factors and the efficacy of the preventive measurements for the in-hospital complications of fall-related fractures. *Methods.* The data on older Chinese patients with fall-related fractures were collected, including information on the patients, diseases, and preventive measurements. The potential risk factors for the in-hospital complications included health status on admission, comorbidity, fractures, preventive measures of the complications, and drugs use for the comorbidity. After univariate analyses, multivariate logistic regression analyses were applied to investigate the impact of the potential risk factors on the number of the complications and each individual complication, respectively, and the efficacy of the preventive measurements. *Results.* A total of 525 male and 1367 female were included in this study. After univariate analyses, multiple logistic regression showed that dementia, pneumonia, antidepressant, postural hypotension, and cerebral infarction could increase the incidence and number of comorbidities. Meanwhile, dementia has shown the strongest association with each individual complication. *Conclusions.* Different combinations of comorbidity, medication use, and preventive measurements were related to the in-hospital complications of fall-related fractures. Dementia emerged as the most important risk factor for these complications, while most of the preventive measurements could not reduce their incidences.

1. Introduction

Falls are an important public health issue among older adults as they are one of the leading causes of fall-related injury and death in the populations [1–4]. Fall-related fracture is one of the most disabling problem of older patients and often trigger a downward spiral in their health which has a close association with the restriction of activity. That may eventually result in many long-term bedfast complications, including pressure ulcer, hospital-acquired pneumonia (HAP), urinary tract infection (UTI), and lower extremity venous thromboembolism (VTE), and even disability or deaths, especially in patients with comorbidity [3, 4].

Several studies have identified the characteristics and potential risk factors for fall-related fractures [1, 3–15]. For example, Sibley et al. [4] studied the relationship between falls and the number of chronic diseases and reported that 62% of fallers had multimorbidity, such as arthritis, visual impairment, hypertension, chronic obstructive pulmonary disease, diabetes, or heart disease, while 23.8% had a single chronic disease. Other studies also showed that comorbidity is an important factor for falls [6, 16]. Some acute diseases

and medication use, such as cardiovascular or psychotropic drugs, also have been considered the primary precipitating risk factors for falls [6, 17].

However, there are limited studies on risk factors and preventive measurements for in-hospital complications of fall-related fractures. This study is an attempt to identify the risk factors for in-hospital complications of fall-related fractures among older Chinese patients and if the preventive measurements used in the clinical activities could decrease the incidence of these in-hospital complications. We collected health and clinical characteristics on patients, including their comorbidity conditions, medication use, and other health statuses of the populations, and tried to explore the interactive relationships between these viable and preventive measurements and their impact on the incidences of in-hospital complications.

2. Materials and Methods

2.1. Design and Patients. This retrospective study was conducted at Chinese PLA General Hospital and approved by the hospital's Ethics and Institutional Review Committees (Code: S2014-055-07). The waiver of patients' informed consent was granted due to the retrospective nature and anonymous patients data of the study. Data were obtained on old Chinese patients with fall-related fractures who were admitted to the Department of Orthopedics and Trauma at the Chinese PLA General Hospital between April 2004 and July 2014. Eligible patients were those aged 60 years or older who had fall-related fractures on admission.

Patients who were admitted with high energy fractures caused by traffic accident or high falling were excluded from the study. Patients who were transferred from other hospitals were also excluded.

2.2. Information on the Patients and Diseases. Information on the patients and injuries was obtained from the electrical medical records. Six types of in-hospital complications were noted, including pressure ulcer, HAP, UTI, lower extremity VTE, constipation, foot drop, and incision complications. The potential risk factors for the in-hospital complications of fall-related fractures were classified as the following five categories: physical status on admission, comorbidities, fracture sites, preventive measures of the in-hospital complications, and drugs use for the comorbidities. Two individual doctors collected half of all the data in an independent manner and checked it with each other after entire collection.

The physical status on admission includes nutritional status, conscious status, and sensory impairment. The nutritional status is assessed by using the short-form Mini-Nutritional Assessment and classified as three grades (malnourished, moderate/at risk of malnutrition, and normal) according to the protocol [18]. The conscious status is classified as five grades, including normal, confusion, delirium, somnolence, and coma, in order of decreased level. Sensory impairment is defined as hearing or vision impairment. The comorbidities include cardiovascular diseases (hypertension, coronary heart disease, postural hypotension, atrial fibrillation, ventricular tachycardia, supraventricular tachycardia, atrial flutter, atrioventricular block, sick sinus syndrome, ventricular premature beat, acute myocardial infarction, rheumatic heart disease, sinus bradycardia, hyperlipemia, etc.), central nervous system (CNS) diseases (cerebral infarction, dementia, cerebral hemorrhage, transient ischemic attack, Parkinson's disease, myasthenia gravis, epilepsy, etc.), bone and joint diseases (osteoarthritis, osteoporosis, protrusion of intervertebral disc, pathological fracture, bone hyperplasia, cervical spondylosis, etc.), respiratory system diseases (pneumonia, chronic obstructive pulmonary disease, etc.), diabetes, cataract, and anemia. In addition, skin problems were also noted, including broken skin, skin yellowing, hematocyanosis, rash, hyperpigmentation, ochrodermia, edema, dehydration, furuncle, petechia, bruise or blood spot, scar, and pale skin.

The fracture site includes radial fracture, femoral neck fracture, femoral intertrochanteric fracture, femoral shaft fracture, spinal fracture, and minor fracture, and the characteristics of fracture are classified as upper extremity, lower extremity, and spinal or multiple fractures.

2.3. Preventive Measures of In-Hospital Complications. In our clinical activities, several preventive measures of complications were used as a routine nursing work and performed on the included patients. The number and combination of the preventive measures performed were dependent on different attending doctors' decision based on the condition of each patient.

The preventive measures of pressure ulcer include (1) replacing the clothes and sheets regularly and keeping the bed clean and dry; (2) keeping the crissum and entire skin clean and dry; (3) turning patients over regularly; (4) providing patients dietary guidance; (5) other preventive measures.

The preventive measures of HAP include (1) guiding patients to deep breathing and coughing exercises; (2) assisting patients to regularly change the posture; (3) turning patients over and knocking back regularly; (4) atomization inhalation treatment; (5) other preventive measures.

The preventive measures of UTI include (1) drinking plenty of water; (2) disinfecting the urinary catheter regularly; (3) clipping the urinary catheter intermittently and instructing patients to strengthen the urinary sphincter with bladder training exercises; (4) replacing the urine bag and catheter regularly; (5) bladder irrigation regularly; (6) other preventive measures.

The preventive measures of lower extremity VTE include (1) guiding patients with lower limb functional exercise regularly; (2) wearing antithrombotic pressure belt with double lower limbs; (3) anticoagulant drugs use; (4) other preventive measures.

The preventive measures of constipation include (1) eating high-fiber foods; (2) taking abdominal massage regularly; (3) using glycerine enema or other laxatives; (4) other preventive measures.

2.4. Statistical Analysis. After proving normal distribution of the data, the mean differences of the continuous data between groups were compared by independent samples

Table 1: The patients' general information.

	Male (N = 525, mean ± SD)	Female (N = 1367, mean ± SD)	p	Total (N = 1892, mean ± SD)	Range
Age (years)	77.31 ± 8.16	75.74 ± 8.7	<0.001	76.18 ± 8.58	60–101
Hospital LOS (days)	14.75 ± 17.40	11.68 ± 24.39	0.008	12.53 ± 22.71	0–615
Grade 1 nursing (days)	11.94 ± 13.2	9.19 ± 21.26	0.006	9.95 ± 19.4	0–527

N: number; SD: standard deviation; LOS: length of stay.

t-test. Pearson's Chi square test and Fisher's exact test were used for detecting the interaction of two categorical variables. Kruskal-Wallis test was used for intergroup comparisons of three or multiple categorical variables. Correlations between categorical variables were determined using Spearman's correlation analysis. After univariate analyses, ordinal or multivariate analyses were applied to investigate the potential risk factors for the number of complications and each individual complication, respectively. The validity of the model was tested by Hosmer-Lemeshow statistic for goodness of fit. The hazard ratio of the potential risk factor was expressed as odds ratio (OR) values or regression coefficients (β). A p value less than 0.05 was considered statistically significant. All statistical procedures were accomplished with SPSS 20 software (SPSS Inc., Chicago, IL, USA).

3. Results

The population included are of a mean age of 76.18 years with 525 male and 1367 female. Both hospital length of stay (LOS) and length of grade 1 nursing are significantly longer in the male than female group. The general information is summarized in Table 1.

3.1. Comparison of the Health and Clinical Characteristics. Table 2 presents the comparison of the physical status and clinical characteristics between genders. It can be shown that the incidences of normal or malnourished nutritional status, femoral shaft fractures, thoracic vertebra fractures, and other minor fractures were significantly higher in female than male group with all p values < 0.05. The incidences of one or two CNS diseases, intertrochanteric fractures, and upper or lower extremity fractures were significantly higher in male than female group with all p values < 0.05. Spearman's correlation analysis shows that age has a significantly positive correlation with lower extremity fractures ($r = 0.367$, $p < 0.001$) and negative correlations with upper extremity fractures ($r = -0.361$, $p < 0.001$) and spinal fractures ($r = -0.128$, $p < 0.001$). However, the negative association of age to spinal fractures only exists in female group ($r = -0.141$, $p < 0.001$).

There are also significantly positive correlations of the number of comorbidities to hospital length of stay ($r = 0.141$, $p < 0.001$) and length of grade 1 nursing ($r = 0.13$, $p < 0.001$). Meanwhile, 48.57% of male and 46.65% of female patients have two comorbidities and over, although there is no significant difference of the number of comorbidities between genders.

The differences of the numbers of the preventive measures of the complications are also not consistent between genders (Table 2). However, there are no significant differences of the number of the complications or the incidences of each individual complication between different genders groups (Table 3).

3.2. Univariate and Multivariate Analysis for the Factors of the Conscious Status. Pearson's Chi square test shows that intertrochanteric fracture, cerebral hemorrhage, cerebral infarction, dementia, other CNS diseases, diabetes, antidiabetic drug, antidepressant, pale skin, other skin diseases, constipation, sensory impairment, and nutritional status are risk factors for the conscious status (Table 4). Kruskal-Wallis one-way ANOVA shows that the age is significantly higher in the "confusion" group than in the "normal" group ($p < 0.001$) and higher in the "somnolence" group than in the "confusion" group ($p = 0.024$).

With the factors abovementioned as independent variables ordinal logistic regression also shows that age, nutritional status, dementia, and pale skin are independent risk factors for conscious status (Table 5).

Spearman's correlation analysis also shows that there are weak but significant positive correlations between conscious status and age ($r = 0.112$, $p < 0.001$), nutritional status ($r = 0.131$, $p < 0.001$), sensory impairment ($r = 0.108$, $p < 0.001$), dementia ($r = 0.154$, $p < 0.001$), and pale skin ($r = 0.104$, $p < 0.001$).

3.3. Univariate and Multivariate Analysis for the Factors of Each Individual Complication. Pearson's Chi square test shows that femoral shaft fracture, broken skin, cerebral hemorrhage, dementia, turning over regularly, skin yellowing, rash, other skin problems, hypertension, and anemia are all risk factors for pressure ulcer. However, multivariate analysis shows that only femoral shaft fracture (OR = 23.64, $p = 0.023$), broken skin (OR = 14.324, $p = 0.07$), cerebral hemorrhage (OR = 555.49, $p = 0.002$), dementia (OR = 145.3, $p = 0.002$), and turning over regularly (OR = 0.039, $p = 0.017$) are independent risk factors for pressure ulcer (Table 6).

Pearson's Chi square test shows that atrial fibrillation, cerebral infarction, dementia, changing posture regularly, and antihypertensive drugs are all risk factors for HAP. However, multivariate analysis excludes the risk of antihypertensive drugs (Table 7).

Univariate analysis of the risk of urinary tract infection shows that cerebral infarction, dementia, anemia, drinking more water, bladder irrigation, broken skin, skin yellowing, rash, and cerebral hemorrhage are all risk factors for UTI. However, multivariate logistic regression shows that only

Table 2: Comparison of the physical status and characteristics of injuries between genders.

Factors	Grade/*N*	Male/*N* (%)	Female/*N* (%)	*p*	Total/*N* (%)
Nutritional status				0.036	
	Normal	340 (64.76)	953 (69.71)	0.038	1293 (68.34)
	Moderate	175 (33.33)	377 (27.58)	0.203	552 (29.17)
	Malnourished	10 (1.9)	37 (2.71)	0.013	47 (2.48)
Mental status				0.433	
	Normal	506 (96.38)	1320 (96.56)	0.726	1826 (96.51)
	Confusion	18 (3.43)	44 (3.22)	0.818	62 (3.27)
	Delirium	1 (0.19)	0	0.277	1 (0.05)
	Somnolence	0	2 (0.15)	0.522	2 (0.11)
	Coma	0	1 (0.07)	0.723	1
Sensory impairment	No	451 (85.9)	1216 (88.95)	0.067	1667 (88.11)
	Yes	74 (14.1)	151 (11.05)	0.067	225 (11.89)
Dermal problems				0.335	
	0	126 (24)	347 (25.38)	0.534	473 (25)
	1	388 (73.9)	1000 (73.15)	0.74	1388 (73.36)
	2	10 (1.9)	20 (1.46)	0.307	30 (1.59)
	3	1 (0.19)	0	0.277	1 (0.05)
Cardiovascular diseases				0.596	
	0	260 (49.52)	630 (46.09)	0.18	890 (47.04)
	1	199 (37.7)	534 (39.06)	0.589	733 (38.74)
	2	61 (11.62)	186 (13.61)	0.251	247 (13.05)
	3	5 (0.95)	16 (1.17)	0.685	21 (1.11)
	4	0	1 (0.07)	0.723	1 (0.05)
CNS diseases				<0.001	
	0	367 (69.9)	1094 (80.03)	<0.001	1461 (77.22)
	1	137 (26.1)	246 (18)	<0.001	383 (20.24)
	2	19 (3.62)	23 (1.68)	0.011	42 (2.22)
	3	2 (0.38)	4 (0.29)	0.53	6 (0.32)
Bone and joint diseases				0.187	
	0	461 (87.81)	1185 (86.69)	0.515	1646 (87)
	1	59 (11.24)	177 (12.95)	0.313	236 (12.47)
	2	5 (0.95)	4 (0.29)	0.073	9 (0.48)
	3	0	1 (0.07)	0.723	1 (0.05)
Respiratory system diseases	0	504 (96)	1317 (96.34)	0.408	1821 (96.25)
	1	21 (4)	50 (3.66)	0.408	71 (3.75)
Fracture site				0.018[a]	
	Radius	61 (11.6)	154 (11.3)	0.828	215 (11.36)
	Femoral shaft	23 (4.4)	91 (6.7)	0.037	114 (6.3)
	Femoral neck	199 (37.9)	487 (35.6)	0.356	686 (36.26)
	Intertrochanteric	196 (37.3)	409 (29.9)	0.001	605 (31.98)
	Lumbar vertebra	35 (6.7)	104 (7.6)	0.276	139 (7.35)
	Thoracic vertebra	0	16 (1.2)	0.005	16 (0.85)
	Minor fracture	26 (5)	131 (9.6)	<0.001	157 (8.3)
Fracture characteristics				0.076	
	Upper extremity	56 (10.67)	186 (13.61)	0.049	242 (12.79)
	Lower extremity	409 (77.9)	1000 (73.15)	0.019	1409 (74.47)
	Spine	42 (8)	144 (10.53)	0.056	186 (9.83)
	Multiple	18 (3.43)	37 (2.71)	0.243	55 (2.91)

Table 2: Continued.

Factors	Grade/*N*	Male/*N* (%)	Female/*N* (%)	*p*	Total/*N* (%)
Preventive measures of pressure ulcer				0.001	
	0	3 (0.57)	5 (0.37)	0.074	8 (0.42)
	1	5 (0.95)	12 (0.88)	0.029	17 (0.9)
	2	128 (24.38)	327 (23.92)	<0.001	455 (24.05)
	3	59 (11.24)	272 (19.9)	0.013	331 (17.49)
	4	226 (43.05)	520 (38.04)	<0.001	746 (39.43)
	5	104 (19.81)	231 (16.9)	0.002	335 (17.71)
Preventive measures of HAP				0.009	
	0	0	3 (0.22)	0.377	3 (0.16)
	1	11 (2.1)	28 (2.05)	0.007	39 (2.06)
	2	9 (1.71)	26 (1.9)	0.479	35 (1.85)
	3	286 (54.48)	863 (63.13)	0.005	1149 (60.73)
	4	191 (36.38)	399 (29.19)	0.004	590 (31.18)
	5	28 (5.33)	48 (3.51)	0.016	76 (4.02)
Preventive measures of UTI				0.028	
	0	3 (0.57)	11 (0.8)	0.01	14 (0.74)
	1	106 (20.19)	365 (26.7)	<0.001	471 (24.89)
	2	18 (3.43)	62 (4.54)	0.364	80 (4.23)
	3	100 (19.05)	251 (18.36)	<0.001	351 (18.55)
	4	269 (51.24)	592 (43.31)	0.402	861 (45.51)
	5	28 (5.33)	85 (6.22)	0.482	113 (5.97)
	6	1 (0.19)	1 (0.07)	0.522	2 (0.11)
Preventive measures of lower extremity VTE				0.058	
	0	7 (1.33)	8 (0.59)	0.007	15 (0.79)
	1	238 (45.33)	669 (48.94)	<0.001	907 (47.94)
	2	231 (44)	526 (38.48)	<0.001	757 (40.01)
	3	48 (9.14)	159 (11.63)	<0.001	207 (10.94)
	4	1 (0.19)	5 (0.37)	0.53	6 (0.32)
Preventive measures of constipation				0.628	
	0	12 (2.29)	23 (1.68)	<0.001	35 (1.85)
	1	373 (71.05)	961 (70.3)	0.001	1334 (70.51)
	2	137 (26.1)	378 (27.65)	<0.001	515 (27.22)
	3	3 (0.57)	4 (0.29)	0.621	7 (0.37)
	4	0	1 (0.07)	0.723	1 (0.05)

[a]Wilcoxon test; *N*: number; UTI: urinary tract infection; VTE: venous thromboembolism; HAP: hospital-acquired pneumonia; PU: pressure ulcer; CNS: central nervous system.

cerebral infarction, dementia, anemia, drinking more water, and bladder irrigation are independent risk factors for UTI. Meanwhile, the risk of UTI development can be significantly reduced by drinking more water (OR = 0.013, $p = 0.021$) but increased by bladder irrigation (OR = 14.954, $p = 0.009$) (Table 8).

Both univariate and multivariate analyses for the influencing factors of foot drop show that broken skin, cerebral infarction, dementia, and postural hypotension are independent risk factors for foot drop (Table 9).

3.4. Univariate and Multivariate Analysis for the Factors of the Complications Number. Pearson's Chi square test shows that the numbers of CNS diseases, respiratory system diseases, and dermal problems are significantly different between different groups of the complications number (Table 10). Spearman's correlation analysis shows that there are weak but significantly positive correlations between the complications number and the number of CNS diseases ($r = 0.09$, $p < 0.001$) and respiratory system diseases ($r = 0.072$, $p < 0.001$), respectively. Kruskal-Wallis one-way ANOVA shows that the complications numbers are shown significantly greater in one or two CNS diseases groups than in no CNS disease group with p values of 0.008 and 0.014, respectively, and not significantly different between other groups.

With the number of CNS diseases, respiratory system diseases, and dermal problems as independent variables, ordinal logistic regression also shows that the number of CNS

Table 3: Comparison of the complications rates between genders.

Factors	N	Male/N (%)	Female/N (%)	p	Total/N (%)
Total complications				0.592	
	0	520 (99.04)	1356 (99.19)	0.47	1876 (99.15)
	1	3 (0.57)	4 (0.29)	0.302	7 (0.37)
	2	2 (0.38)	2 (0.15)	0.309	4 (0.21)
	3	0	1 (0.07)	0.723	1 (0.05)
	4	0	1 (0.07)	0.723	1 (0.05)
	5	0	3 (0.22)	0.377	3 (0.16)
Pressure ulcer		0	6 (0.44)	0.142	6 (0.31)
HAP		2 (0.38)	7 (0.51)	0.524	9 (0.48)
UTI		0	5 (0.37)	0.196	5 (0.26)
VTE		0	1 (0.07)	0.723	1 (0.05)
Constipation		0	3 (0.22)	0.377	3 (0.16)
Foot drop		3 (0.57)	7 (0.51)	0.555	10 (0.53)
Incision problem		2 (0.38)	1 (0.07)	0.188	3 (0.16)

N: number; UTI: urinary tract infection; VTE: venous thromboembolism; HAP: hospital-acquired pneumonia.

diseases and respiratory system diseases are independent risk factors for the complications number (Table 10).

When all individual potential risk factors are analysed by Pearson's Chi square test, it can be shown that broken skin, skin yellowing and rash, hematocyanosis, hyperpigmentation, cerebral infarction and hemorrhage, dementia, pneumonia, postural hypotension, antidepressant, femoral shaft fracture, osteoarthritis, and anemia are risk factors for the number of the complications (Table 11). However, multivariate analysis shows that only dementia, pneumonia, antidepressant, postural hypotension, and cerebral infarction are independent risk factors for the number of the complications (Table 12).

4. Discussion

To our knowledge, this is the first study to explore and describe the relationships between the conditions of comorbidity, medication use, health characteristics, preventive measurements, and the incidences of in-hospital complications. Except lower extremity VTE, constipation, and incision complications, the risk factors for other four complications could be determined using multiple logistic regression model. Vu et al. reported that men hospitalized due to a fall had a higher comorbidity rate than women [12]. However, our findings were discordant with their results.

4.1. Conscious Status. In Freter et al.'s study, age was not a risk factor for preoperative delirium, and the strongest association with preoperative delirium was cognitive impairment, substance use, sensory impairment, and wait time for surgery in fall-related hip fracture patients [19]. Our study cannot reveal any independent risk factors for delirium. However, it is shown that antidepressant use is a risk factor for decreased level of conscious status in univariate analysis (OR = 29.532, $p = 0.001$) (Table 4), and multiple logistic regression model has age, nutritional status, dementia, and sensory impairment as independent risk factors for decreased level of conscious status after adjustment for other potential risk factors (Table 5).

4.2. Pressure Ulcer. Kwong et al. showed that bedfast or chairfast patients with stroke were at higher risk for pressure ulcer development [20]. Van Marum et al. also found cerebrovascular accident was a risk factor for decubitus ulcers [21].

In our findings, the cerebral hemorrhage is also an independent risk factor for pressure ulcer development; however, to turn patients over regularly can significantly decrease the risk of pressure ulcer.

Meanwhile, pressure ulcer in univariate analysis was significantly associated with poorer Glasgow coma scale in traumatic brain injury patients [22]. Sayar et al. also found that pressure ulcer development had significant correlation with decreased level of consciousness [23].

However, we cannot find this relationship in the fall-related fracture patients. The possible reason might be that the fracture patients included in our study all accepted the operative treatment which could reduce LOS in the bed and permit the patients early rehabilitation exercise, mobilization, and comprehensive nursing postoperatively even for the patients with severe consciousness impairment.

4.3. HAP. HAP is one of the most common nosocomial infections. In the present study, two male (0.38%) and seven female (0.51%) patients developed HAP, and there is no significant difference of HAP incidence between genders.

Sopena et al. reported that patients with malnutrition, anemia, depression of consciousness, and comorbidity had higher incidence of HAP [24]. Zhu et al. proposed that atrial fibrillation was an independent risk factor for HAP [25]. In Guzmán-Herrador et al.'s study, decreased level of consciousness on admission was a risk factor for HAP [26].

In the present study, in addition to atrial fibrillation and decreased level of conscious state we find that cerebral infarction and dementia significantly increase the incidence of HAP.

4.4. UTI. Redder et al. reported that patients with hospital-acquired UTI used indwelling urinary catheters more frequently and had more genitourinary or nervous system diseases than the control group [27]. In the present study, CNS diseases, especially cerebral infarction and dementia, can increase the incidence of hospital-acquired UTI.

In Hagerty et al.'s study, anemia was a variable significantly associated with hospital-acquired UTI in patients with subarachnoid hemorrhage [28]. In our multiple regression

Table 4: Pearson's Chi square test for the risk factors of conscious status.

Factors	Yes/no	Conscious status					χ^2/p
		1	2	3	4	5	
Intertrochanteric fracture	No	1253	33	0	0	1	13.392/0.01
	Yes	573	29	1	2	0	
Cerebral hemorrhage	No	1801	62	1	0	1	139.118/<0.001
	Yes	25	0	0	2	0	
Cerebral infarction	No	1663	55	0	2	1	10.773/0.029
	Yes	163	7	1	0	0	
Dementia	No	1808	55	1	2	1	48.886/<0.001
	Yes	18	7	0	0	0	
Other CNS diseases	No	1708	59	1	2	0	14.982/0.005
	Yes	118	3	0	0	1	
Diabetes	No	1502	55	1	0	0	15.945/0.003
	Yes	324	7	0	2	1	
Antidiabetic drug	No	1508	57	1	0	0	18.315/0.001
	Yes	318	5	0	2	1	
Antidepressant	No	1826	61	1	2	1	29.532/0.001
	Yes	0	1	0	0	0	
Pale skin	No	1813	58	1	2	1	22.221/<0.001
	Yes	13	4	0	0	0	
Other skin problems	No	1059	47	0	0	0	13.473/0.009
	Yes	767	15	1	2	1	
Constipation	No	1825	61	1	2	1	13.791/0.008
	Yes	1	1	0	0	0	
Sensory impairment	No	1621	42	1	2	1	25.854/<0.001
	Yes	205	20	0	0	0	
Nutritional status	Normal	1267	22	1	2	1	68/<0.001
	Moderate	522	30	0	0	0	
	Malnourished	37	10	0	0	0	

CNS: central nervous system.

Table 5: Ordinal logistic regression for conscious status[1].

Factors	Grade	β	p	95% CI for β
Age		0.043	0.023	0.006–0.079
Nutritional status	Normal	−1.935	<0.001	−2.82–−1.049
	Moderate	−1.337	0.002	−2.188–−0.486
	Malnourished	0		
Dementia	No	−2.145	<0.001	−3.124–−1.165
	Yes	0		
Sensory impairment	No	−0.708	0.02	−1.305–−0.111
	Yes	0		

[1]Hosmer-Lemeshow test, $p < 0.001$; β: regression coefficient; CI: confidential interval.

model, anemia is also an independent risk factor for hospital-acquired UTI in fall-related fractures patients (OR = 39.985, $p = 0.034$). In addition, the preventive measure of bladder irrigation also can increase the incidence of UTI (OR = 14.954, $p = 0.009$), while drinking more water is a protective factor for this complication (OR = 0.013, $p = 0.021$).

4.5. Foot Drop. The complication of foot drop has been shown to be an association with knee dislocation and ligaments' injures and knee arthroplasty surgery [29, 30].

In the present study, 10 patients (0.53%) developed foot drop during hospitalization. Multiple logistic regression model shows that patients with postural hypotension (OR = 68.657, $p = 0.002$), dementia (OR = 19.223, $p = 0.002$), broken skin (OR = 10.826, $p = 0.001$), and cerebral infarction (OR = 7.165, $p = 0.011$) are at a higher risk for foot drop development. The possible reason might be the longer time in bed for these patients. However, we cannot find the differences of hospital length of stay or grade 1 nursing between the patients with these comorbidities and without them.

4.6. Complications Number. Harvey et al. reported that patients with dementia were disproportionately represented in injury-related hospitalizations, experienced longer hospital LOS, and had poorer outcomes [31]. Other studies

Table 6: Univariate and multivariate analysis for risk factors of pressure ulcer.

Factors	Univariate analysis			Multivariate logistic regression[1]		
	OR	p	95% CI	OR	p	95% CI
Femoral shaft fracture	7.92	0.005	1.435–43.704	23.640	0.023	1.541–362.673
Broken skin	12.597	<0.001	2.27–69.904	14.324	0.07	0.806–254.494
Cerebral hemorrhage	14.308	0.002	1.615–126.778	555.49	0.002	10.017–30805.37
Dementia	40.5	<0.001	7.063–232.241	145.3	0.003	5.711–3697.031
Turning over regularly	0.036	<0.001	0.006–0.201	0.039	0.017	0.003–0.562
Skin yellowing	34.091	<0.001	3.676–316.197			
Skin rash	20.756	<0.001	2.308–186.691			
Other skin problems	0.995	0.039	0.99–0.999			
Hypertension	0.994	0.034	0.99–0.999			
Anemia	14.308	0.002	1.615–126.778			

[1]Hosmer-Lemeshow test, $p = 0.217$; OR: odds ratio; CI: confidential interval.

Table 7: Univariate and multivariate analysis for risk factors of hospital-acquired pneumonia.

Factors	Univariate analysis			Multivariate logistic regression[1]		
	OR	p	95% CI	OR	p	95% CI
Atrial fibrillation	95.789	0.004	4.184–2192.782	95.789	0.007	6.42–1890.43
Cerebral infarction	5.104	0.011	1.265–20.594	25.791	0.001	3.728–178.45
Dementia	23.106	<0.001	4.553–117.267	8.545	0.007	1.795–40.678
Conscious state	1.138	0.031	1.017–2.139	1.850	0.007	0.511–3.189
Antihypertensive drugs	0.992	0.011	0.987–0.997			

[1]Hosmer-Lemeshow test, $p = 0.629$; OR: odds ratio; CI: confidential interval.

Table 8: Univariate and multivariate analysis of risk factors for urinary tract infection.

Factors	Univariate analysis			Multivariate logistic regression[1]		
	OR	p	95% CI	OR	p	95% CI
Cerebral infarction	6.777	0.016	1.125–40.842	88.807	0.026	1.688–4671.192
Dementia	54.029	<0.001	8.617–338.782	1017.668	0.002	12.626–82027.991
Anemia	17.894	<0.001	1.933–165.622	39.985	0.034	1.317–1213.702
Drinking more water	0.043	<0.001	0.005–0.401	0.013	0.021	0.000–0.515
Bladder irrigation	25.716	<0.001	4.251–155.588	14.954	0.009	1.983–112.788
Skin yellowing	42.636	<0.001	4.405–412.712			
Skin rash	25.958	<0.001	2.764–243.819			
Broken skin	16.806	<0.001	2.765–102.139			
Cerebral hemorrhage	17.894	<0.001	1.933–165.622			

[1]Hosmer-Lemeshow test, $p = 0.652$; OR: odds ratio; CI: confidential interval.

Table 9: Univariate and multivariate analysis for risk factors of foot drop.

Factors	Univariate analysis			Multivariate logistic regression[1]		
	OR	p	95% CI	OR	p	95% CI
Broken skin	17.257	<0.001	4.762–62.534	10.826	0.001	2.640–44.388
Cerebral infarction	4.372	0.02	1.12–17.066	7.165	0.011	1.567–32.77
Dementia	20.207	<0.001	4.067–100.396	19.223	0.002	2.915–126.765
Postural hypotension	52.167	<0.001	5.298–513.636	68.657	0.002	4.801–981.923

[1]Hosmer-Lemeshow test, $p = 0.398$; OR: odds ratio; CI: confidential interval.

Table 10: Univariate and multivariate analysis for risk factors of the number of complications.

Comorbidities	N	Univariate analysis							Ordinal logistic regression[1]		
		Complications						χ^2/p	β	p	95% CI for β
		0	1	2	3	4	5				
CNS diseases	0	1455	3	3	0	0	0	34.236/0.003	14.785	<0.001	13.157–16.412
	1	375	3	1	1	1	2		16.432	<0.001	14.853–18.011
	2	40	1	0	0	0	1		17.255		17.255–17.255
	3	6	0	0	0	0	0		0		
Respiratory system diseases	0	1808	4	4	1	1	3	30.072/<0.001	−1.788	0.007	−3.079–−0.498
	1	68	3	0	0	0	0		0		
Dermal problems	0	468	1	2	1	1	0	27.808/0.023			
	1	1378	6	2	0	0	2				
	2	29	0	0	0	0	1				
	3	1	0	0	0	0	0				

[1]Hosmer-Lemeshow test for CNS diseases and respiratory system diseases, $p = 0.005$ and 0.022, respectively; β: regression coefficient; CNS: central nervous system.

Table 11: Univariate analysis for risk factors of the number of complications.

Factors	Univariate analysis	
	χ^2	p
Cerebral infarction	22.378	<0.001
Dementia	98.549	<0.001
Pneumonia	32.099	<0.001
Postural hypotension	52.423	<0.001
Antidepressant	88.58	<0.001
Broken skin	38.418	<0.001
Femoral shaft fracture	17.387	0.004
Skin yellowing	51.049	<0.001
Hematocyanosis	28.338	<0.001
Skin rash	31.709	<0.001
Hyperpigmentation	18.587	0.002
Cerebral hemorrhage	21.921	0.001
Osteoarthritis	14.201	0.014
Anemia	21.921	0.001

also showed that delirium was associated with several complications, including longer hospital LOS, more function and cognition impairment, increased risk of nursing home placement, and even death, in elderly orthopedic patients [32–35].

In our findings, dementia is also shown to be the strongest association with all the types of complications. However, we cannot find that hospital LOS is longer in dementia patients than patients without it. Besides dementia, cerebral infarction and broken skin are also independent risk factors for four and three types of complications, respectively. However, multiple logistic regression model only has pneumonia, postural hypotension, and antidepressant as independent risk factors for the complications number rather than broken skin.

4.7. Limitations. This study has several limitations. First, we cannot determine the risk factors for lower extremity VTE, constipation, and incision complications based on the present database. The possible reason might be that the incidences of the lower extremity VTE, constipation, and incision complications were too low with 0.05%, 0.16%, and 0.16%, respectively. Second, most of the preventive measures of the complications analysed in this study cannot increase or reduce the incidences of in-hospital complications analysed, except the self-contradictory impact of bladder irrigation and drinking more water on UTI. Third, no control group but only fall-related fracture patients are included and analysed. Thus, the risk factors for fall-related fractures cannot be explored and analysed in this study. Fourth, no long-term follow-up results, such as internal fixation failure or death, and the corresponding incidences and risks factors are collected and determined.

5. Conclusion

Different combinations of comorbidity, medication use, and preventive measurements were related to the number and pattern of in-hospital complications of patients with fall-related fractures. Dementia emerged as the most important risk factor for these complications, while most of the preventive measurements could not reduce the incidence of the in-hospital complications. Continued studies are still warranted to verify these associations and determine how to incorporate consideration of comorbidity into preventive assessments of in-hospital complications of fall-related fractures.

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Competing Interests

The authors declare that they have no conflict of interests.

Table 12: Ordinal logistic regression for risk factors of the number of complications.

Factors	Yes/no	Ordinal logistic regression[1]		
		β	p	95% CI for β
Cerebral infarction	No	−1.610	0.028	−3.045–−0.175
	Yes	0		
Dementia	No	−3.232	<0.001	−4.936–−1.527
	Yes	0		
Pneumonia	No	−2.162	0.007	−3.741–−0.582
	Yes	0		
Postural hypotension	No	−3.495	0.024	−6.530–−0.460
	Yes	0		
Antidepressant	No	−4.251	0.007	−7.358–−1.144
	Yes	0		

[1]Hosmer-Lemeshow test, $p < 0.001$; β: regression coefficient; CI: confidential interval.

Authors' Contributions

Jing Wang and Yuan Gao collected the data and drafted the manuscript. Hong-Ying Pi and Meng-Meng Hu revised the manuscript. Hong-Ying Pi and Yuan Gao conceived the study and participated in its design and coordination. Statistical analysis was done by Pei-Pei Peng and Dan Nie. All authors read and approved the final manuscript.

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