

Analysis of the Distribution Characteristics of Falls and Risk Factors for Fall-Related Injuries among 110 Elderly Inpatients

Xiong Yinhuan¹, Dong Yameng¹, Shu Liping¹, Hu Lixia², Cui Kai¹, Zhang Ying^{1, a, *}

¹*Nursing Department, Binzhou People's Hospital, Binzhou, Shandong, China*

²*Hepatobiliary Surgery, Binzhou People's Hospital, Binzhou, Shandong, China*

^a*ying789123@126.com*

**Correspondence author*

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Abstract: A retrospective analysis on the distribution features of falls and risk factors for fall injuries was conducted in 110 elderly inpatients to provide a basis for preventing fall injuries among the elderly. A total of 110 fall-related adverse events reported in the adverse event system of Binzhou People's Hospital from January 2021 to December 2023, involving patients aged ≥ 60 years, were selected to analyze the distribution characteristics of the fall population and influencing factors of fall injuries. Among the 110 patients who experienced a fall, 53.63% sustained injuries as a result of the fall. The results of the logistic regression analysis showed that the probability of sustaining an injury from a fall between 6:00 PM and 10:00 PM was 5.077 times higher than that between 8:00 AM and 5:59 PM (95% CI=1.161—22.205, $P=0.031$), the probability of injury from a fall during the 23:00—7:59 time period was 2.408 times that of the 8:00—17:59 time period (95% CI=1.03—5.632, $P=0.043$), and the probability of sustaining an injury from a fall among those with a history of falls in the past three months was 5.455 times higher than among those without such a history (95% CI =1.479—20.122, $P=0.011$). The severity of injuries sustained by elderly inpatients following a fall is associated with the time of day the fall occurred and their history of falls over the past three months. It is recommended that high-risk periods be designated as priority monitoring periods, and that dynamic assessments and personalized interventions for patients with a recent history of falls be strengthened to reduce the risk of fall-related injuries.

1. Introduction

A fall is defined as an unplanned, involuntary, and unintentional change in body position that results in the body landing on the ground or a lower surface, regardless of whether it causes injury [1]. Data from the seventh national census show that the proportion of the population aged ≥ 60

years in China has reached 18.7% ^[2]. With the acceleration of population aging in China, health issues among older adults have become increasingly prominent. Against this backdrop, falls have become one of the leading causes of injury and death among the elderly^[3], and rank among the top three adverse events in hospitalized patients in medical institutions. Once elderly inpatients fall, it often leads to serious consequences such as joint injuries and fractures, delays the recovery process of patients, increases the hospitalization burden of patients, and simultaneously reduces the operational efficiency of hospitals ^[4]. Therefore, preventing falls among hospitalized patients and reducing the severity of fall-related injuries is not only a common topic in global medical safety but also an important part of the core patient safety goals of the Chinese Hospital Association. This study aimed to analyze the distribution characteristics, severity of fall injuries, and influencing factors of 110 fall incidents among elderly inpatients, with the goal of formulating targeted prevention strategies and providing references for ensuring patient safety.

2. Objectives and Methods

2.1 Research Subjects

This study was a retrospective analysis. Elderly patients who experienced falls during their hospitalization at a tertiary grade A hospital in Binzhou City from January 1, 2022 to December 31, 2023 were selected as the research subjects, with a total of 110 cases included. The inclusion criteria were as follows: ① age ≥ 60 years; ② experienced a fall during hospitalization and met the fall diagnosis criteria ^[5]; ③ the fall event was properly reported to the hospital's adverse event system. Exclusion criteria: Patients with incomplete or missing information and those whose data sources could not be traced. According to whether the fall event caused injury to the patient, the included patients were divided into the fall without injury group and the fall with injury group, aiming to analyze the influencing factors of fall injuries. This study was approved by the Binzhou People's Hospital Medical Ethics Committee (2024B) No. 581.

2.2 Research Methods

2.2.1 Patient Demographic Questionnaire

This questionnaire includes 19 items, such as age, educational level, history of falls, circumstances of the fall, seasonal distribution of falls, location of falls from bed, severity of fall-related injuries, and activities of daily living (ADL) scores.

2.2.2 Morse Fall Risk Assessment Scale

This scale was developed by Morse et al at the University of Pennsylvania and is used to measure the risk of falls among hospitalized patients. The scale consists of six items, including history of falls in the past three months, visual impairment, and mental status. Based on the score, patients were classified into three risk categories: low risk (<25 points), moderate risk (25–45 points), and high risk (≥ 45 points)^[6].

2.3 Statistical Methods

Data were analyzed using SPSS 22.0 software. Continuous variables are expressed as mean $\pm$ standard deviation ($\bar{X} \pm S$), and categorical variables are described as frequencies (percentages).

Intergroup comparisons were performed using the chi-square (χ^2) test. A binary logistic regression model was used to analyze the risk factors for fall-related injuries, with $P < 0.05$ indicating statistical significance.

3. Results

3.1 Distribution of Clinical Characteristics

Among the 110 fall-related adverse events, 60 involved males (54.55%) and 50 involved females (45.45%); the most common educational level among patients who fell was elementary school or below (60%); the third quarter had the highest number of falls (33.64%); The most common underlying medical conditions among patients who fell were neurological disorders (23.64%), followed by cardiovascular diseases (18.18%); the most frequent location of falls was within the ward—at the bedside (45.45%); the primary nursing level involved was N2 (63.64%). For details, see Table 1.

3.2 Distribution of Fall Incidents

Fall-related injuries accounted for 53.63% of all injuries, with grade 1 injuries being the most common (35.45%), followed by grade 3 injuries (13.64%). (See Table 2.)

3.3 Univariate Analysis of Fall Injuries

The analysis results indicated that variables such as a history of falls within the past 3 months, time of occurrence, and Morse score at admission were all statistically significant ($P < 0.05$). (See Table 1.)

Table 1: Demographic Characteristics of Hospitalized Patients Who Suffered Falls [n(%)]

Items	Description	Total (n=110)	No Injury Group (n=51)	Fall with Injury Group (n=59)	Chi-square value	P-value
Sex	Male	60 (54.5)	31 (60.8)	29 (49.2)	1.493	0.222
	Female	50 (45.5)	20 (39.2)	30 (50.8)		
Educational Attainment	Elementary school or below	66 (60.0)	28 (54.9)	38 (34.5)	4.232	0.121
	Junior High	25 (22.7)	16 (31.4)	9 (36.0)		
	High school and above	19 (17.3)	7 (13.7)	12 (20.3)		
Visual impairment	None	79 (71.8)	38 (74.5)	41 (69.5)	0.340	0.560
	Yes	31 (28.2)	13 (25.5)	18 (30.5)		
History of falls in the past 3 months	No history of falls	92 (83.6)	48 (94.1)	44 (74.6)	8.325	0.004

	History of falls	18 (16.4)	3 (5.9)	15 (25.4)		
Use of high-risk medications associated with patient falls	No	50 (45.5)	24 (47.1)	26 (44.1)	0.099	0.753
	Yes	60 (54.5)	27 (52.9)	33 (55.9)		
Do you use any assistive devices?	No	102 (92.7)	46 (90.2)	56 (94.9)	0.903	0.342
	Yes	8 (7.3)	5 (9.8)	3 (5.1)		
Quarterly Distribution	First Quarter	18 (16.4)	9 (17.6)	9 (15.3)	5.092	0.165
	Second Quarter	31 (28.2)	10 (19.6)	21 (35.6)		
	Third Quarter	37 (33.6)	17 (33.3)	20 (33.9)		
	Fourth Quarter	24 (21.8)	15 (29.4)	9 (15.3)		
Altered consciousness	None	105 (95.5)	50 (98.0)	55 (93.2)	1.464	0.266
	Yes	5 (4.5)	1 (2.0)	4 (6.8)		
Time of occurrence	8:00—17:59	49 (44.5)	22 (43.1)	13 (22.0)	6.688	0.035
	17:59—22:59	41 (37.3)	3 (5.9)	9 (15.3)		
	23:00—7:59	20 (18.2)	26 (51.0)	37 (62.7)		
Nurse Level,n(%)	N0	1 (0.9)	1 (2.0)	0 (0)	4.066	0.254
	N1	17 (15.5)	11 (21.6)	6 (10.2)		
	N2	70 (63.6)	30 (58.8)	40 (67.8)		
	N3	22 (20.0)	9 (17.6)	13 (22.0)		
Nursing Title,n(%)	Nurse	1 (0.90)	1 (2.0)	0 (0)	0.217	0.159
	Registered Nurse	31 (28.2)	18 (35.3)	13 (22.0)		
	Senior Nurse	77 (70.0)	31 (60.8)	46 (78.0)		
	Associate Chief Nurse	1 (0.9)	1 (2.0)	0 (0)		
Self-care ability,n(%)	No dependency	18 (16.4)	9 (17.6)	9 (15.3)	3.053	0.384
	Mild dependence	48 (43.6)	26 (51.0)	22		

				(37.3)		
	Moderate dependence	27 (24.5)	10 (19.6)	17 (28.8)		
	Severe dependence	17 (15.5)	6 (11.8)	11 (18.6)		
Muscle strength,n(%)	Normal	101 (91.8)	45 (88.2)	56 (94.9)	1.625	0.202
	Decrease	9 (8.20)	6 (11.8)	3 (5.1)		
Disease Type,n(%)	Neurological disorders	26 (23.6)	9 (17.6)	17 (28.8)	6.399	0.781
	Cancer-related diseases	3 (2.7)	1 (2.0)	2 (3.4)		
	Respiratory diseases	10 (9.10)	4 (7.8)	6 (10.2)		
	Cardiovascular diseases	20 (18.2)	8 (15.7)	12 (20.3)		
	Endocrine System Diseases	12 (10.9)	7 (13.7)	5 (8.5)		
	Digestive System Diseases	12 (10.9)	6 (11.8)	6 (10.2)		
	Musculoskeletal System Diseases	7 (6.4)	4 (7.8)	3 (5.1)		
	Urinary system diseases	7 (6.4)	4 (7.8)	3 (5.1)		
	Rheumatic Diseases	5 (4.5)	4 (7.8)	1 (1.7)		
	Hematological Diseases	5 (4.5)	2 (3.9)	3 (5.1)		
	Other	3 (2.7)	2 (3.9)	1 (1.7)		
Location of fall,n(%)	In the ward—at the bedside	50 (45.5)	23 (45.1)	27 (45.8)	4.741	0.448
	In-room - Bathroom	31 (28.2)	12 (23.6)	19 (32.2)		
	Inpatient Ward - Patient Room	14 (12.7)	6 (11.8)	8 (13.6)		
	Inside the ward – Corridor	9 (8.2)	5 (9.8)	4 (6.8)		
	Inside the ward - nurses' station	2 (1.8)	2 (3.9)	0 (0)		
	Other	4 (3.6)	3 (5.9)	1 (1.7)		
Scenarios leading to falls,n(%)	Using the restroom	46 (41.8)	22 (43.1)	24 (40.7)	4.831	0.566
	While walking	16 (14.5)	10 (19.6)	6 (10.2)		
	Getting in and out of bed	15 (13.6)	8 (15.7)	7 (11.9)		
	Lying in a hospital bed	11 (10)	3 (5.9)	8 (13.6)		

	Reaching for an object	7 (6.4)	3 (5.9)	4 (6.8)		
	While washing up	4 (3.6)	1 (2.0)	3 (5.1)		
	Other	11 (10.0)	4 (7.8)	7 (11.9)		
With or without a caregiver,n(%)	None	6 (5.5)	2 (3.9)	4 (6.8)	0.433	0.510
	Yes	104 (94.8)	49 (96.1)	55 (93.2)		
BMI(kg/m ²),n (%)	Underweight (<18.5)	13 (11.8)	6 (11.8)	7 (11.9)	1.345	0.719
	Normal (18.5 – 23.9)	42 (38.2)	20 (39.2)	22 (37.3)		
	Overweight (24 – 27.9)	31 (28.2)	12 (23.5)	19 (32.2)		
	Obesity (≥ 28)	79 (71.8)	13 (25.5)	11 (18.6)		
Morse score,n(%)	Moderate risk	7 (28.2)	6 (11.8)	1 (1.7)	4.655	0.031
	High risk	93 (90.0)	45 (88.20)	58 (98.3)		

Table 2: Distribution of Fall Incidents by Type

Items	Example	Composition Ratio(%)
Non-injurious Fall	51	46.36%
Fall-related Injury	59	53.63%
Mild(Severity Level 1)	39	35.45%
Moderate (Severity Level 2)	5	4.55%
Severe (Severity Level 3)	15	13.64%

3.4 Binary Logistic Regression Analysis of Fall-Related Injuries in Hospitalized Patients

Table 3: Logistic Regression Model Coding

Coding	Variable	Assignment
Y	Did the fall cause any injuries	NO harm=1,harm=2
X1	A history of one fall in the past three months	NO=1,YES=2
X2	Time period	7:00-16:59=1,17:00-23:59=2,0:00-6:59=3
X3	Morse score at admission	Moderate risk(25-45points)=1,High risk(>45points)=2

Table 4: Binary Logistic Regression Analysis of Factors Influencing Fall-Related Injuries

Factors to Consider	Category	<i>B</i>	Standard error (<i>SE</i>)	Wald χ^2	<i>P</i>	OR(95%CI)
Time period	18:00-22:00	1.625	0.753	4.657	0.031	5.077(1.161-22.205)
	23:00-7:59	0.879	0.433	4.112	0.043	2.408(1.03-5.632)
Have you experienced any falls in the past 3 months?	With fall history	1.696	0.666	6.488	0.011	5.455(1.479-20.122)

Using the presence or absence of injury from a fall as the dependent variable (no injury = 1, injury=2), variables with statistically significant differences in univariate analysis, namely history of falls in the past three months, time period of occurrence, and Morse score at admission, were included in the regression model, with the assignments shown in Table 3. Logistic regression results showed that the probability of injury from a fall occurring between 18:00-22:00 was 5.077 times higher than that from a fall occurring between 8:00-17:59 (95% CI=1.161-22.205, *P* = 0.031), and the probability of injury from a fall occurring between 23:00-7:59 was 2.408 times higher than that from a fall occurring between 8:00-17:59 (95% CI =1.03-5.632, *P*=0.043); The probability of injury from a fall in patients with a history of falls in the past three months was 5.455 times the probability of injury from a fall in patients without such a history (95% CI=1.479-20.122, *P*=0.011), as shown in Table 4 and Figure 1.

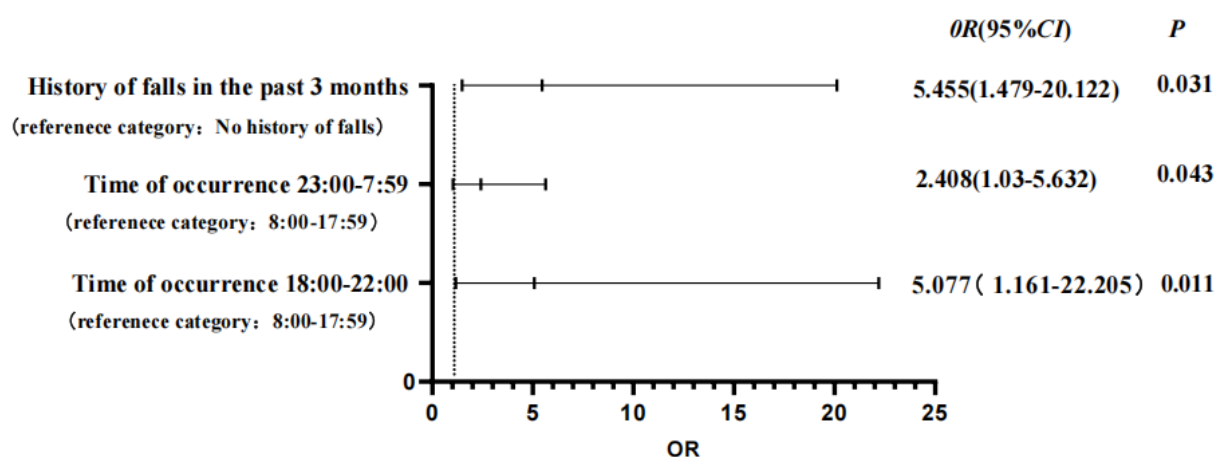


Figure 1 Forest Plot of Independent Risk Factors for Falls among Inpatients

4. Discussion

4.1 Distribution Characteristics of Falls among Elderly Hospitalized Patients

This study analyzed data from hospitalized patients aged ≥ 60 years who experienced falls between January 2022 and December 2023. Fall-related injuries accounted for 53.63% of injuries, which is consistent with domestic research^[7]. Univariate analysis showed that there was no

statistically significant difference in the presence or absence of injury among older adult hospitalized patients in terms of sex, education level, seasonal distribution, disease type, location of fall, BMI, and nurse level ($P>0.05$). The proportion of male to female patients who fell was similar; the highest education level among fall patients was primary school or below (accounting for 60%), which may be related to the impact of education on understanding ability. Lower education levels result in poorer comprehension and reduced ability to receive fall prevention education^[8]. Seasonally, falls occurred most frequently in the third quarter (accounting for 33.64%), corresponding to July, August, and September, which are mainly summer months, consistent with the study by Zhao et al.^[9]. The main disease types in patients with falls were neurological disorders (23.64%), consistent with the findings of the foreign scholar Kobayashi^[10], followed by circulatory system diseases (18.18%). The most common site of falls was beside the bed in the ward (45.45%), followed by the bathroom (32%), consistent with the findings of Jianyu^[11] and Minjie et al.^[12]. Most of the attending nurses were at the N2 level (63.64%), related to the nurse-level structure in our hospital, where N2 level nurses account for 60%.

4.2 Risk Factors for Fall-Related Injuries among Elderly Inpatients

4.2.1 High Probability of Fall-Related Injuries at Night Requires Special Attention

The results of this study indicate that the probability of patients sustaining fall-related injuries is higher during the nighttime hours of 6:00 PM–10:00 PM and 11:00 PM–7:59 AM. These findings are consistent with those of previous domestic and international studies^[13-14]. This may be related to the following reasons: First, environmental factors: Studies have shown^[15] that 67.39% of patient falls are caused by environmental factors. At night, the lights in the patient rooms are turned off, creating a dim environment. Patients' vision is limited when getting out of bed or using the restroom at night, making it difficult for the elderly to identify hazardous environments and avoid obstacles, which leads to fall-related injuries in the elderly. A study by Nong et al.^[16] showed that patients who fell in dimly lit indoor environments had a higher probability of sustaining fall-related injuries. Second, decreased vigilance: There are fewer nursing staff on night shifts, and caregivers are often asleep, which may reduce vigilance toward patients^[17], making it difficult to detect a patient's fall immediately and potentially prolonging the time from the fall to receiving emergency care. Third, patient physiological factors: During nighttime hours, human reaction times and cognitive functions are at their lowest levels. Patients are often in a state of deep sleep or drowsiness, and when there is a sudden change in body position (from lying to standing), the probability of orthostatic hypotension increases^[18], leading to decreased muscle strength and postural instability. Studies have indicated that orthostatic hypotension is an independent risk factor for falls^[19], with a detection rate of 27.3% among patients with grade 3 fall injuries (fractures) who also experience orthostatic hypotension^[20]. Therefore, patients should be provided with a well-lit ward environment at night, and the 8S management system should be implemented to ensure dry floors and orderly arrangement of items within the room. Additionally, increasing the number of night-shift staff and utilizing educational methods such as teach-back and informational tools like bedside screens can enhance patient and caregiver education, raise awareness of the risks of orthostatic hypotension, address knowledge gaps, and increase vigilance. For extremely high-risk patients, the use of sensor-equipped anti-fall mattresses should be considered; when a patient leaves the bed, nurses can receive an immediate alert to prevent the recurrence of fall-related injuries.

4.2.2 Patients with a History of Falls in the Past Three Months Have A Higher Probability of Sustaining Fall-Related Injuries

The results of this study indicate that patients with a history of falls in the past three months have a higher probability of sustaining fall-related injury. The probability of falling in the past three months is 5.455 times higher for those with a history of falls compared to those without. This may be related to the following reasons: on the one hand, patients with a history of falls are prone to developing a fear of falling^[21]. Once this fear sets in, they unconsciously assess their environment—such as the height of bed rails, floor slipperiness, and nighttime lighting—and may even restrict their daily physical activities due to excessive vigilance. This leads to internal physiological issues, such as muscle atrophy and limited mobility, creating a vicious cycle that increases the risk of recurrent fall-related injuries^[22–23]. Conversely, a history of falls within the past three months typically indicates that the individual may have underlying issues such as decreased muscle strength, visual or cognitive impairments, or abnormal gait, or external hazards such as slippery floors in the ward. If these contributing factors are not promptly identified and addressed, the probability of subsequent fall-related injuries will significantly increase. Therefore, healthcare professionals should enhance their ability to anticipate risks, identify and monitor potential fall hazards, and use them as a starting point for developing clinical fall prevention measures to prevent and reduce the incidence of fall-related injuries.

In summary, clinical healthcare providers should incorporate time-based management into fall prevention systems and implement differentiated interventions tailored to specific time periods. Additionally, healthcare providers should be reminded to pay close attention to patients with a history of falls within the past three months, provide education on falls and fall-related injuries to these patients, and improve environmental facilities. Increasing staffing levels can also help reduce the incidence of falls and fall-related injuries. However, this study had a small sample size and was limited to data from a single-center retrospective study. Prospective large-scale studies should be conducted to incorporate multidisciplinary fall risk assessments and comprehensive geriatric assessments as part of fall-related injury prevention strategies.

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