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Original Research Article

Incidence and determinants of falls among tertiary care hospital inpatients in Western India

Meenu Jain*, Supe Avinash, Sanjay M. Mehendale, Aditi Erande

P. D. Hinduja Hospital and MRC, Mumbai, Maharashtra, India

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***Correspondence:**
Dr. Meenu Jain,
E-mail: meenurishijain@gmail.com

ABSTRACT

Background: Inpatient falls are a common and preventable cause of morbidity, prolonged hospital stay, and increased healthcare costs worldwide. However, data on incidence and context-specific risk factors in Indian hospital settings remain limited. Aim was to estimate the incidence of falls among inpatients in a tertiary care hospital in Western India and identify associated risk factors.
Methods: A cross-sectional survey and matched case-control study was conducted in a 560-bedded tertiary care hospital in Western India over 24 months. Among adult inpatients, 97 fall cases were identified and matched (1:2) with controls by gender, admission date, and length of stay. Fall incidence per 1000 person-days and adjusted odds ratios (aOR) were calculated using multivariate logistic regression.
Results: Among 4,179 inpatients, 97 falls occurred over 31,732 person-days (fall rate 2.32%; incidence 3.1 per 1000 person-days). Falls were most common in patients aged >60 years. Independent risk factors included hospital stay >7 days (aOR 5.56), composite vulnerability (aOR 8.82), prior fall within 6 months (aOR 7.21), visual impairment (aOR 75.2), and multiple comorbidities (aOR 5.31). Medication class was not significant on multivariate analysis. Use of sequential compression devices was associated with reduced fall risk (aOR 0.001).
Conclusions: Inpatient falls were associated primarily with patient vulnerability, sensory impairment, clinical complexity, and prolonged hospitalization. We recommend routine surveillance of inpatients to assess composite vulnerability, visual impairment, and other fall-related risk factors, with particular emphasis on patients aged over 60 years, alongside prioritised monitoring based on identified risk indicators.

Keywords: Inpatient falls, Fall incidence, Risk factors, Patient vulnerability, Visual impairment

INTRODUCTION

Inpatient falls are a frequent and major cause of preventable morbidity, occasional mortality, prolonged hospital stay, and increased healthcare costs worldwide.[1,2]

Falls within hospitals result both in immediate harm from fractures and head injuries, as well as long-term consequences such as prolonged length of stay in the hospital and/ or ICU, psychological distress, and increased burden of costs for both patients and health systems.

Older adults, in particular, have an increased risk of fall due to frailty, multi-morbidity, impaired balance, and visual deficits.[3] Fall rates in acute care settings typically range from 1 to 9 per 1000 patient-days, and one-third of patients fall more than once during hospitalisation with a substantial proportion resulting in injury.[4]

Despite the introduction of structured risk-assessment tools and fall-prevention programmes, inpatient falls continue to occur regularly. Therefore, identifying and managing admitted patients and would be inpatients at risk of falls can be an ongoing challenge.[5] The incidence of inpatient falls reported in Indian hospital settings

ranges from approximately 0.5 to 2.5 per 1000 patient-days, although this may be underestimated due to under-reporting and variability in surveillance systems.[4,6-9]

Falls are inherently multifactorial, with risk factors spanning over biological, clinical, and environmental domains. Biological factors such as advanced age, frailty, cognitive impairment, and sensory deficits are consistently associated with increased risk associated with fall.[2,10] Identifying context-specific risk determinants is essential for designing appropriate effective hospital fall-prevention strategies.[11] This study was conducted in a tertiary care hospital in Western India to estimate the incidence of inpatient falls and to determine associated independent risk factors.

METHODS

In the initial phase of this hospital-based study, a cohort study was conducted among all adult patients admitted to a tertiary care hospital in Mumbai, Western India, over a 24-month period (January 2023 to December 2024) to determine the incidence of falls. Only hospital admitted inpatients were included in the study and followed from admission to discharge. The globally accepted definition of fall as "an event which results in a person coming to rest inadvertently on the ground, floor, or other lower level" [World health organization] was adopted in the present study. Falls were identified through hospital incident reports and clinical review within 24 hours of occurrence. Visiting outpatients were excluded from the analysis. Notably, each patient experiencing fall in our study did not report additional falls during the total hospital stay as inpatients.

Study design, setting and participants for determination of risk factors associated with falls among inpatients

In the second phase a matched case-control study was conducted on inpatients who had a fall during the study period (cases) and matched controls chosen from other inpatients who did not experience a fall during their hospital stay (controls). Cases were patients experiencing a fall during the defined hospitalisation period. Controls were patients who did not experience a fall. For each case two controls matched for gender, date of admission and length of hospital stay were selected. Data were extracted from patient medical records for analysis of association of various risk factors with incident fall events among inpatients. Data related to demographic information, clinical status, comorbidities, medication use, details of sensory impairments, functional vulnerability, and record of use of patient care equipment were collected for risk factor analysis. Fall risk was assessed using the Johns Hopkins Fall Risk Assessment Tool.[12]

Statistical analysis

Data were entered and managed using Microsoft excel. Continuous variables (e.g., age, length of stay) were summarised as mean±standard deviation for normally distributed data or median with interquartile range for non-normal data. Categorical variables were expressed as frequencies and percentages.

Normality was assessed using the Kolmogorov-Smirnov test. Group comparisons between cases and controls were performed using independent-samples t tests or Mann-Whitney U tests as appropriate. Associations between categorical variables and falls were evaluated using Chi-square tests.

Using the number of fall events among all the patients admitted between January 2023 and December 2024 as the numerator and the total number of patients admitted during the same period as the denominator, proportion of patients experiencing fall was calculated. Using the number of fall events between January 2023 and December 2024 as the numerator and total duration of follow-up in person days for all the hospitalized patients during the study period, the incidence of fall was measured.

Univariate logistic regression analysis was conducted to assess associations between individual risk factors and fall events. Variables that attained statistical significance in univariate analysis were included in the multivariate logistic regression model to identify the risk factors which were independently associated with inpatient falls. Analyses were performed using IBM SPSS Statistics version 31 and a two-tailed $p<0.05$ was considered as statistically significant.

Ethical considerations

The study was approved by the institutional ethics committee. A written informed consent was taken from all inpatients for the incidence estimation study. A waiver of informed consent was granted for the case-control study because data analysis was based on data extracted from patient medical records without any direct patient contact.

RESULTS

Incidence of falls among inpatients

During the 24-month study period, 4,179 patients contributed 31,732 person-days of hospitalisation. Ninety-seven patients experienced a fall and this yielded overall inpatient fall rate of 2.32%. Incidence of fall among inpatients was 0.31 per 100 person-days (3.1 per 1,000 person-days) of hospitalization.

A total of 97 inpatient falls were analysed across age categories stratified by gender (Table 1). Overall, fall incidence rates were comparable between males and females across various age groups. The highest fall incidence was observed in patients aged >60 years in both males and females (0.41 per 100 person-days), indicating a strong old age-related association with falls in hospitals.

Association between various risk factors and inpatient fall events

Univariate analysis

In univariate logistic regression analysis, several clinical and hospital-related variables were observed to be significantly associated with falls (Table 2).

Hospital stay of more than 7 days was associated with higher odds of falling compared with ≤7 days (OR 2.69, 95% CI 1.60-4.46). Presence of additional comorbidities also showed a strong association (OR 6.51, 95% CI 2.63-16.10) with fall events. Composite patient vulnerability (OR 11.57, 95% CI 2.73-49.06) and a prior history of falls within six months (OR 3.28, 95% CI 1.89-5.69) were significantly associated with fall events.

In the univariate analysis, other factors such as visual impairment (OR 9.26, 95% CI 5.26-16.33), auditory impairment (OR 7.47, 95% CI 1.52-36.67), use of several medication classes including narcotics (OR 13.55, 95% CI 2.97-61.88) and antiepileptics (OR 11.65, 95% CI 3.28-41.32) were found to be associated with falls among inpatients. Use of sequential compression devices was observed to be associated with lower odds of falling (OR 0.03, 95% CI 0.01-0.09).

Multivariate analysis

Results of multiple logistic regression analysis indicated that risk factors such as clinical vulnerability, previous history of falls, and greater comorbidity burden were independently associated with fall events among inpatients (Table 2). Longer hospital stay and visual impairment also showed an independent association with falls among inpatients.

Some variables that were associated at a statistically significant level in univariate analysis, such as consumption of several classes of medication and auditory impairment, did not retain significance in the regression analysis after adjustment in the multivariate model. Use of sequential compression devices was found to be associated with lower odds of falling, however, the differences in supervision/mobility might actually could have caused a direct protective effect. Estimates for some variables were unstable because of small subgroup sizes.

Table 1: Incidence of fall in inpatient.

Gender	Age (in years)	Fall	No fall	Total	P value (Chi Square test)	Person days	Incidence per 100 person days
Male	≤40	7	434	441	0.0556	3343	0.21
	41-60	14	818	832		6254	0.22
	>60	36	1114	1150		8827	0.41
Female	≤40	6	335	341	0.1572	2528	0.24
	41-60	11	655	666		5097	0.22
	>60	23	726	749		5683	0.41

Table 2: Risk factors associated with fall in inpatients (univariate and multivariate logistic regression).

Variables				Univariate logistic regression		Multivariate logistic regression	
Categories		**Fall, (n=97)**	**No fall, (n=194)**	**P value**	**P value**	**Odds ratio (95% CI)**	**P value**	**Odds ratio (95% CI)**
Patient clinical factors								
Length of stay	≤7	51 (26%)	145 (74%)	0.0001	1	Reference	1	Reference
	>7	46 (48.4%)	49 (51.6%)		0.0002	2.69 (1.6-4.46)		
BMI	Normal	39 (33.6%)	77 (66.4%)	0.2	1	Reference	0.003	5.56 (1.79-17.27)
	Underweight	5 (45.5%)	6 (54.5%)		0.43	1.64 (0.47-5.73)		
	Overweight	39 (37.9%)	64 (62.1%)		0.51	1.2 (0.69-2.09)		
	Obese	14 (23%)	47 (77%)		0.14	0.58 (0.29-1.19)		
Patient comorbidities								
Other comorbidities	Absent	78 (29.4%)	187 (70.6%)	0.0001	1	Reference	1	Reference
	Present	19 (73.1%)	7 (26.9%)		0.0001	6.51 (2.63-16.1)	0.0404	5.31 (1.08-26.24)
DM	Absent	39 (48.7%)	41 (51.2%)	0.0006	1	Reference	1	Reference

Continued.

Variables					Univariate logistic regression		Multivariate logistic regression	
Categories		**Fall, (n=97)**	**No fall, (n=194)**	**P value**	**P value**	**Odds ratio (95% CI)**	**P value**	**Odds ratio (95% CI)**
	Present	58 (27.5%)	153 (72.5%)		0.007	0.4 (0.23-0.68)	0.2017	0.39 (0.09-1.65)
Stroke	Absent	91 (31.9%)	194 (68.1%)	0.0005	1	Reference		
	Present	6 (100%)	0 (0%)		0.99	3132748682		
Patient clinical factors								
Patient vulnerability	No	2 (5%)	38 (95%)	0.0001	1	Reference	1	Reference
	Yes	95 (37.8%)	156 (62.2%)		0.0009	11.57 (2.73-49.06)	0.0272	8.82 (1.28-60.89)
Mobility status	Independent	23 (27.7%)	60 (72.3%)	0.3924	1	Reference		
	Moderate dependent	52 (36.6%)	90 (63.4%)		0.17	1.5 (0.84-2.72)		
	Very dependent	22 (33.3%)	44 (66.7%)		0.46	1.30 (0.65-2.63)		
Previous history of fall within 6 months	No	58 (26.5%)	161 (73.5%)	0.0001	1	Reference	1	Reference
	Yes	39 (54.2%)	33 (45.8%)		0.0001	3.28 (1.89-5.69)	0.0069	7.21 (1.72-30.23)
Gait pattern	Normal	96 (33.1%)	194 (66.9%)	0.1573	1	Reference		
	Unsteady	1 (100%)	0 (0%)		0.99	401889684		
Visual impairment	Absent	36 (18%)	164 (82%)	0.0001	1	Reference	1	Reference
	Present	61 (67%)	30 (33%)		0.0001	9.26 (5.26-16.33)	0.0001	75.2 (13.33-424.31)
Auditory impairment	absent	90 (31.9%)	192 (68.1%)	0.0041	1	Reference	1	Reference
	Present	7 (77.8%)	2 (22.2%)		0.0013	7.47 (1.52-36.67)	0.5854	0.36 (0.009-13.88)
Elimination pattern incontinence	No	96 (39.5%)	147 (60.5%)	0.0001	1	Reference		
	Yes	1 (2.1%)	47 (97.9%)		0.0008	0.03 (0.004-0.24)		
Conscious and oriented (Cognition)	No	0 (0%)	35 (100%)	0.0001	1	Reference		
	yes	97 (37.9%)	159 (62.1%)		0.99	4323944409		
Altered awareness of immediate physical environment (Cognition)	No	97 (35.5%)	176 (64.5%)	0.002	1	Reference		
	Yes	0 (0%)	18 (100%)		0.99	6.9587E-10		
Impulsive (Cognition)	No	97 (35.3%)	178 (64.7%)	0.0037	1	Reference		
	Yes	0 (0%)	16 (100%)		0.99	7.0378E-10		
Lack of understanding of one's physical cognition limitation (Cognition)	No	97 (33.4%)	193 (66.6%)	0.4795	1	Reference		
	Yes	0 (0%)	1 (100%)		0.99	0		
Chest tube (Patient care equipment)	No	97 (34.6%)	183 (65.4%)	0.017	1	Reference		
	Yes	0 (0%)	11 (100%)		0.99	7.2355E-10		
Indwelling catheter (Patient care equipment)	No	97 (43.1%)	128 (56.9%)	0.0001	1	Reference		
	Yes	0 (0%)	66 (100%)		0.99	1.8618E-10		
SCD	No	93	82	0.0001	1	Reference	1	Reference

Continued.

Variables					Univariate logistic regression		Multivariate logistic regression	
Categories		**Fall, (n=97)**	**No fall, (n=194)**	**P value**	**P value**	**Odds ratio (95% CI)**	**P value**	**Odds ratio (95% CI)**
sequential compression device (Patient care equipment)		(53.1%)	(46.9%)					
	Yes	4 (3.4%)	112 (96.6%)		0.0001	0.03 (0.01-0.09)	0.0001	0.001 (0.0001-0.009)
Patient medication								
Use of laxative	No	43 (26.5%)	119 (73.5%)	0.006	1	Reference	1	Reference
	Yes	54 (41.9%)	75 (58.1%)		0.006	1.99 (1.22-3.27)	0.9199	1.06 (0.37-3.02)
Use of diuretic	No	57 (27.8%)	148 (72.2%)	0.002	1	Reference	1	Reference
	Yes	40 (46.5%)	46 (53.5%)		0.002	2.26 (1.34-3.81)	0.6157	0.73 (0.21-2.51)
Use of antihypertensive	No	19 (20.4%)	74 (79.6%)	0.0014	1	Reference		
	Yes	78 (39.4%)	120 (60.6%)		0.0017	2.53 (1.42-4.52)		
Use of narcotics	No	85 (30.7%)	192 (69.3%)	0.0001	1	Reference	1	Reference
	Yes	12 (85.7%)	2 (14.3%)		0.0008	13.55 (2.97-61.88)	0.1189	10.09 (0.55-184.20)
Use of opioid	No	83 (31%)	185 (69%)	0.0036	1	Reference	1	Reference
	Yes	14 (60.9%)	9 (39.1%)		0.0054	3.47 (1.44-8.33)	0.7841	1.29 (0.21-7.79)
Use of antidepressant	No	92 (32.4%)	192 (67.6%)	0.0307	1	Reference		
	Yes	5 (71.4%)	2 (28.6%)		0.05	5.22 (0.99-27.4)		
Use of oral diabetic drug	No	47 (40.5%)	69 (59.5%)	0.0346	1	Reference	1	Reference
	Yes	50 (28.6%)	125 (71.4%)		0.035	0.59 (0.36-0.96)	0.6609	0.72 (0.16-3.19)
Use of anticoagulant	No	49 (27.2%)	131 (72.8%)	0.0049	1	Reference	1	Reference
	Yes	48 (43.2%)	63 (56.8%)		0.0052	2.04 (1.24-3.35)	0.1387	2.36 (0.76-7.32)
Use of antiepileptic	No	82 (30%)	191 (70%)	0.0001	1	Reference	1	Reference
	Yes	15 (83.3%)	3 (16.7%)		0.0001	11.65 (3.28-41.32)	0.1	10.44 (0.64-171.02)

DISCUSSION

In this large tertiary hospital care-based study in Western Indian, we have documented the incidence rates of falls among hospitalized patients. Our reported incidence of 0.31 per 100 person days or 3.1 per thousand person days highlights the significance of the problem. Overall, the rate of fall among 4179 patients admitted over the study duration of 24 months was 2.3%. Hospital inpatient fall rates reported in the literature vary widely but generally fall within a similar order of magnitude. In acute care settings internationally, fall rates have been reported between 1.3 and 16.9 falls per 1,000 patient-days, with pooled estimates often ranging from 1 to 9 per 1,000 patient-days across diverse hospital types and patient populations.[13] A recent multicentre survey from Switzerland and Austria reported inpatient fall proportions of 3.4% and 3.9%, respectively, in nearly 44,000 patients.[14] Although there are relatively few published Indian papers, smaller hospital audits suggest inpatient fall rates in tertiary care settings that are comparable to the reported lower international estimates of 0.3 falls per 1,000 patient-days in a Malaysian hospital study.[15] Taken together, our incidence findings fall within the reported global literature and underscore that inpatient falls remain an important safety outcome in hospitalised populations in a LMIC setting like India where systematic surveillance and reporting mechanisms are often less established.

In the matched case-control analysis independent predictors of falls were composite patient vulnerability, prior fall within six months, multi-morbidity, visual

impairment, and hospital stay exceeding seven days. Although individual disease diagnoses and specific medication classes were not independently associated with falls in our study, we believe that there would be some benefit of monitoring the admitted patients belonging to this category. Our findings reinforce the observation that inpatient falls are likely to be driven more by overall clinical complexity of presentation and functional risk than by isolated medical conditions or pharmacological exposures.[16] The strength of our study was that we performed a two-step analysis. Initially we conducted univariate analysis and identified variables showing significant associations and then we performed multiple regression analysis to identify all such factors that were independent associated with the outcome variable of "falls in inpatients" at a statistically significant level.

Our results are consistent with international evidence indicating that falls in hospitalised patients happen as a result of interplay between various intrinsic and extrinsic factors reflecting a multi-factorial nature. Systematic reviews have identified frailty, functional impairment, and prior falls as some of the strongest predictors of inpatient fall risk, often outweighing demographic variables such as age alone.[4,17] The strong association observed in our study between composite vulnerability and falls supports the growing recognition that fall susceptibility is more likely to be multidimensional rather than dependent on single clinical indicators or conditions.

We are reporting composite vulnerability as a strong predictor of falls. We defined patient vulnerability as functional dependence in activities of daily living, impaired mobility requiring assistance, and cognitive or sensory impairment documented at admission. Other studies have also reported multidimensional frailty as an outperforming variable compared to isolated functional or diagnostic variables in predicting adverse outcomes, including falls.[18,19] Functional decline during hospitalisation is common and may occur rapidly, particularly in acutely ill patients, further amplifying the risk of falls.[20] These observations emphasise the need for careful and repeated risk assessment during hospital stay, because risk of fall is dynamic rather than static. Careful monitoring of several risk factors in case of vulnerable patients can be an excellent opportunity to prevent inpatient falls.

We observed that the presence of multiple comorbidities was independently associated with higher risk of fall, suggesting that the hospital care staff must remain more alert and vigilant in patients with clinical complexities in the context of fall prevention. Multimorbidity has been linked to increased fall risk through mechanisms such as polypharmacy, fluctuating physiological status, reduced mobility, and cumulative disease burden.[21,22] These findings reinforce that recording history of associated morbidity in addition to the primary clinical condition at the time of admission is of critical importance in the context of fall prevention. Nursing care providers can be more vigilant in case of patients with co-morbidities in implementation of fall prevention protocols.

Visual impairment showed a strong association with falls in our study. This is absolutely consistent with extensive evidence linking poor vision to impaired environmental awareness and increased hazard exposure.[23,24] Hospital settings present additional visual challenges such as unfamiliar layouts, variable lighting, and medical equipment, which may exacerbate the risk of fall.[25] Although the estimate in our study had a wide confidence interval, the direction and strength of association support the importance of sensory screening and environmental optimisation as an integral component of fall prevention programmes.

We observed that several medication classes were associated with falls in univariate analysis but they did not retain their significance in the regression analysis. Previous studies have documented that medications such as sedatives, opioids, and psychotropics contribute to risk of fall primarily in conjunction with underlying frailty and illness severity.[26-28] It will be important to tease out the difference between the falls resulting from medications by themselves or their use in presence of risk modifiers through prospective cohort studies. Nevertheless, compliance to guidelines that recommend comprehensive medication review within the broader fall risk assessment frameworks would be beneficial.

The observed association between sequential compression device use and lower risk of fall will require additional evidence generation in our opinion. We were not able to statistically analyse the possibility of role of increased supervision, reduced mobility, or higher levels of nursing vigilance on the observed association of potential use of device resulting in reducing the number of falls among the users. Similar paradoxical associations have been described in hospital safety research, where markers of intensive monitoring appear protective because they serve as proxies for closer observation.[29]

Longer hospital stay was observed to be independently associated with falls in the adjusted regression model, indicating that cumulative longer hospitalization itself might increase the risk of fall. Prolonged hospitalisation may lead to deconditioning, sleep disruption, delirium, and increased mobility limitations, all of which have been linked to fall risk associated with longer hospital stay.[12,30] This finding highlights the primary principle that every possible effort should be made to ensure that the patient does not remain admitted in the hospital beyond what is actually medically required.

Limitations

Limitations include the single-centre setting, sparse data for some predictors leading to wide confidence intervals, and the retrospective observational study design for the

risk factor association study, which limit the causal inferences. Multicentre prospective studies in diverse hospital settings are needed to validate these findings and refine risk prediction models. Future work should also explore temporal changes in fall risk and evaluate whether designed targeted interventions can actually lower the incidence of fall particularly among highly vulnerable patients.

CONCLUSION

Inpatient falls in this tertiary care hospital setting were mainly associated with clinical vulnerability, prior falls, comorbidity burden, sensory impairment, and prolonged hospitalization, rather than specific diagnoses or medication classes. Routine, multifactorial fall risk assessment should be implemented at admission and during hospital stay, with emphasis on older adults. High-risk patients require targeted interventions and closer monitoring, and standardized surveillance systems should be adopted for accurate benchmarking.

Recommendations

These findings suggest that fall prevention strategies should prioritise integrated vulnerability assessment, including functional status, prior falls, sensory deficits, and comorbidity burden. Interventions focusing solely on age, diagnosis, or medication class may overlook key determinants. Multidisciplinary collaboration and regular reassessment for compliance to established hospital protocols remain critical in fall prevention among hospital inpatients.

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