



Predictors of falls and hospitalization outcomes in elderly patients admitted to an acute geriatric unit

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ABSTRACT

We aimed to identify fall incidence, predictors and characteristics and to investigate hospitalization outcomes for elderly inpatients. In 340 men and 280 women consecutively admitted to a Acute Geriatric Ward of a University Hospital the following variables were evaluated: demographics, clinical history, main disease responsible for hospitalization, comorbidity (cumulative illness rating scale: CIRS 1 and 2) gait and balance deficit (Tinetti's scales), cognition/function (short portable mental status questionnaire: SPMSQ); activities of daily living: ADL; instrumental activities of daily living: IADL; delirium (confusion assessment method: CAM), drugs administered during hospitalization. Overall 80 falls occurred in 70 patients. The incidence rate of falls was of 6.0 per 1000 patient-days with 2.0 falls per bed/year. Age (relative risk = RR = 1.050; 95% confidence interval = CI = 1.013–1.087), delirium (RR = 3.577; 95% CI 1.096–11.672), diabetes (RR = 5.913; 95% CI 1.693–20.644), balance deficit (RR = 0.914; 95% CI 0.861–0.970) and polypharmacy (RR = 1.226; 95% CI 1.122–1.340) were independently predictive of falling. Fallers had a prolonged length of stay (LOS) (35.5 ± 47.8 days vs. 23.2 ± 27.2; $p = 0.01$) and more frequent nursing home placements (12.9% vs. 5.6%; $p < 0.005$). The knowledge of falling predictors might help in planning specific preventive strategies to improve the patients' global health status and to reduce the costs of medical care.

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1. Introduction

Falls are a very common type of inpatient accident (ANARI, 2004; Nakai et al., 2006) and with their physical and psychological consequences might compromise an already impaired functional status or cause severe morbidity and mortality in old people (Rubenstein and Josephson, 2006). The incidence of falls rises steadily from middle-aged people and peaks in those who are over 80 years (Rubenstein and Josephson, 2002). In hospitalized people, fall rates might vary from 3 to 13 per 1000 patient-days, depending on department type and patient population, as reported in a recent review (Oliver et al., 2007).

Most falls result from a complex interplay of predisposing and precipitating factors in people's environment and in individual demographic and clinical characteristics. Hospitalization itself may be an important risk factor in falls, representing a deep change in elderly patients' life habits. In addition, preventing hospital falls

requires knowledge of falls and injury circumstances in different settings (Krauss et al., 2007).

Considering that an early identification of hospitalized patients at risk of falling might help to prevent this issue, the aim of our study was to evaluate fall incidence, predictors and characteristics and to investigate hospitalization outcomes for elderly inpatients admitted to a Geriatric Acute Care Ward of a University Hospital.

2. Materials and methods

Approval was obtained by the Local Ethic Committee. This longitudinal observational study recruited 620 patients (mean age 79.3 ± 8.9 years) consecutively admitted to the Geriatric Acute Care Unit of San Giovanni Battista Hospital in Turin, between August 1st 2006 and December 31st 2007.

Upon hospital admission, using predefined forms, we gathered the following variables for each patient: demographic data (age, sex), the main disease causing hospital admission, the associated pathologies, according to the International Classification of Diseases, Ninth Revision Clinical Modification, (ICD-9-CM) and the concomitant diseases through the CIRS with both the index of severity (CIRS 1) and the index of comorbidity (CIRS 2) (Linn et al.,

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1968). Furthermore, we evaluated the body mass index (BMI), the presence of visual impairment, incontinence, sleep–wake disturbance and orthostatic hypotension (defined as a 20 mmHg fall in systolic blood pressure on assuming an upright posture from a supine position).

We also investigated the gait and balance disturbances through Tinetti's performance-oriented assessment of gait and his performance-oriented assessment of balance (Tinetti, 1986), respectively. These tests are scored on the patient's ability to perform specific tasks. The maximum scores for the gait components and the balance components are 12 and 16, respectively. We also noted the number of prior falls in the last 6 months, the presence of mechanical restraints (bed rails or soft restraining vests) and the need for ambulation assistive devices.

Functional status was assessed through the ADL (Katz et al., 1963), and the IADL (Lawton and Brody, 1969). Patients with ADL score ≥ 1 or IADL ≤ 5 were considered functionally dependent. We evaluated the cognitive status through the SPMSQ (Pfeiffer, 1975) and the presence of delirium symptoms through the CAM (Inouye et al., 1990). Patients with SPMSQ score ranging from 3 to 4, 5 to 7 and 8 to 10 were considered suffering from mild, moderate and severe intellectual impairments, respectively. The CAM is an assessment instrument that screens for clinical features of delirium and correlates to DSM IV criteria. The short version includes only those four features that were found to have the greatest ability to distinguish delirium from other types of cognitive impairments.

We also assessed the outcomes of hospitalization (LOS, death, nursing home placement, discharge to home) and the pharmacological therapies administered to the patients during hospitalization.

In this study a "fall" was defined as any event registered as a fall in the medical or nursing records (Tutuarima et al., 1997); we only considered the occurrence of complete falls (not avoided nor assisted falls). For each fall we noted time, setting, circumstances, number of days between the hospital admission and the fall and its clinical consequences (wounds, fractures, subdural hematoma).

2.1. Statistical analysis

The statistical analysis was performed using SPSS, version 11.5 for Windows. In the univariate analysis we used χ^2 -test and Student's *t*-test to evaluate dichotomous and continuous variables, respectively. Significant variables were then introduced into the multivariate analysis by means of logistic regression model to identify the main predictors of falling during hospitalization.

3. Results

During the study period, 80 falls occurred in 70 hospitalized patients (11.3% of the 620 subjects enrolled). Among these 70 fallers, 9 (12.8%) fell more than once. The total number of patient-days was 13,356 for 28 beds with an incidence rate of falls of 6.0 falls per 1000 patient-days and 2.0 falls per bed/year.

Fallers were older than non-fallers (82.1 ± 7.9 years vs. 78.9 ± 8.9 years, $p < 0.001$). No difference in fall incidence was found between men (12.9%) and women (10.0%). Mortality rate was similar among fallers and non-fallers (11.4% and 11.3%, respectively). A prolonged LOS (35.5 ± 47.8 days vs. 23.2 ± 27.2 days; $p = 0.01$) and nursing home placements (12.9% vs. 5.6%; $p < 0.005$) were more frequent among fallers than non-fallers.

Table 1 shows the incidence and the characteristics of falls. Roughly half of falls (51.5%) occurred within the first week of hospitalization and particularly within the first 3 days. The majority of events happened in the daytime and in the patients'

Table 1
Incidence and characteristics of falls

	Number	% of fallen patients
Time between hospitalization and 1st fall		
≤ 3 days	27	38.6
4 days–1 week	9	12.9
1–2 weeks	22	31.4
2 weeks–1 month	7	10
>1 month	5	7.1
Timing of fall (round the clock)		
24–6	20	25
6–13	28	35
13–20	23	28.7
20–24	9	11.3
Location of fall		
Patient's room	59	73.7
Toilet/bathroom	11	13.7
Corridor	10	12.6
Circumstances of fall		
During ambulation	32	40
From the wheel-chair	7	8.7
From the bed	41	51.3
Clinical consequences of falling		
None	53	75.7
Lacerations	9	12.8
Femur fracture	2	2.9
Humer fracture	2	2.9
Vertebral fracture	1	1.4
Other fractures	2	2.9
Subdural hematoma	1	1.4

room. Only 13.7% of falls occur in the bathroom and 12.6% in the corridors. 51% of falls took place from the patients' bed.

A significantly greater number of patients who had resulted to be dependent in ADL fell performing basic activities of daily living, but we did not find any difference in incidence related to IADL and SPMSQ scores (Table 2). As summarized in Table 3 fallers scored significantly lower on Tinetti's scales for both balance and gait (4.90 ± 5.04 and 5.04 ± 4.57 vs. 7.49 ± 6.25 and 6.99 ± 5.42 , respectively; $p < 0.01$). The need for assistive devices for ambulation was associated to superior incidence of falling (22% vs. 10.4%, $p < 0.05$), whereas there was no statistically significant relationship with a prior history of falling, using wheel-chair and physical restraints.

Delirious symptoms, as defined in the CAM scale, were also associated with superior incidence of falls (27.3% vs. 10.7%). Moreover, patients affected by endocrino-metabolic and genitourinary diseases fell more than patients without these pathologies. (31.3% vs. 10.8% and 25% vs. 10.8%, respectively). We did not find

Table 2
Relationship between functional and cognitive status and falls: *N* (%)

	Total	Fallers	<i>p</i>
IADL			
Independent	267	22 (8.2)	ns
Partially dependent	155	20 (12.9)	ns
Dependent	198	28 (14.1)	ns
ADL			
Independent	286	22 (7.7)	<0.001
Dependent	334	48 (14.4)	<0.001
SPMSQ (level of cognitive impairment)			
None/slight	430	47 (10.9)	ns
Moderate	83	13 (15.7)	ns
Severe	107	10 (9.3)	ns

Note: ns = not significant.

Table 3
Relationship between Tinetti scale, ambulation, history of prior falls and falls: mean \pm S.D. or N (%)

	Total	Non-fallers	Fallers	p
Tinetti scale				
Balance	7.19 \pm 6.17	7.49 \pm 6.25	4.90 \pm 5.04	<0.01
Gait	6.67 \pm 5.11	6.99 \pm 5.42	5.04 \pm 4.57	<0.01
Use of ambulation devices				
No	570	511 (89.6)	59 (10.4)	<0.05
Yes	50	39 (78.0)	11 (22.0)	<0.05
Use of bed-rise				
No	572	506 (88.5)	66 (11.5)	ns
Yes	48	44 (91.7)	4 (8.3)	ns
Use of wheel-chair				
No	526	471 (89.5)	55 (10.5)	ns
Yes	94	79 (84)	15 (16)	ns
No. of falls in the last 6 months before hospital admission				
None	460	411 (89.3)	49 (10.7)	ns
1 fall	106	95 (89.6)	11 (10.4)	ns
2 or more falls	54	44 (81.5)	10 (18.5)	ns

Table 4
Variables independently predictive of falls according to a multivariate analysis by means of logistic regression model

	β	\pm S.E.M.	RR	CI 95%	p
Age	0.048	0.018	1.050	1.013–1.087	<0.01
Balance impairment (Tinetti scale)	-0.090	0.030	0.914	0.861–0.970	<0.01
Delirium	1.274	0.603	3.577	1.096–11.672	<0.05
Endocrino-metabolic disease					
	1.777	0.638	5.913	1.693–20.644	<0.01
Polypharmacy	0.204	0.045	1.226	1.122–1.340	<0.001

any difference related to CIRS 1 and CIRS 2 scores, BMI, visual impairment, incontinence, sleep-wake disturbance and orthostatic hypotension.

Some therapies administered during hospitalization, such as benzodiazepines, antidepressants, narcotics, calcium channel antagonists, diuretics and non-steroidal anti-inflammatory drugs were significantly associated to a higher number of falls. Furthermore, we found a significantly larger number of administered drugs in faller (5.63 \pm 2.50) than in non-fallers (3.03 \pm 3.38).

Age, the performance-oriented assessment of balance by Tinetti score, the presence of delirium, endocrino-metabolic disease and polypharmacy proved to be independently associated with the falls, as showed in Table 4.

Falls did not cause serious injuries in most cases (75.7%). The most frequent consequence was a wound. 2.9% of patients sustained a hip fracture and one patient suffered from subdural hematoma as a result of a head trauma.

4. Discussion

In our study 70 elderly inpatients (11.3%) fell during hospitalization in an Acute Geriatric Ward and the incidence rate of fall was 6.0 falls per 1000 patient-days and 2.0 falls per bed/year. In medical literature data on this subject are not homogeneous because of the variety of patients and settings evaluated and the research designs. In previous study conducted in hospitalized patients the incidence of falls was 11.7 fall per 1000 patients-days in Swiss geriatric departments (Schwendimann et al., 2006), 8.9 in stroke elderly patients (Tutuarima et al., 1997), 6.12 in medicine and neurology services (Hitcho et al., 2004) and up to 15.9 in a

geriatric unit for stroke rehabilitation (Nyberg and Gustafson, 1995). Frail and poly pathological patients tend to fall more frequently.

We found that falls occur more often during the first week of hospitalization (51.3%). This finding reinforces the hypothesis that hospitalization, leading to a loss of habitual benchmarks, itself represents an important and avoidable risk factor of falling. In elderly patients it is necessary to carefully evaluate the risk-to-benefit ratio before hospitalizing a subject, preferring a home based care setting (i.e., Home Hospitalization Services), whenever possible (Aimonino Ricauda et al., 2004, 2008).

The majority of events happened in the daytime and in the patients' room and roughly half of fall occurred when the patient was in bed, in keeping with previous study (Tutuarima et al., 1997). Only 13.7% of falls occur in the bathroom and 12.6% in the corridors. The patient functional status influenced the circumstances and the setting of falls. Patients without ambulation deficits fell more frequently in the room, in the bathroom and in the corridors, whereas subjects with impaired functional or cognitive status fell from the bed, attempting to climb over the bed rails or wandering aimlessly (Mahoney, 1998). Moreover, the patients who scored worse on the ADL scale fell more frequently performing activities of daily living, as reported in previous studies (Rubenstein and Josephson, 2006).

In our study balance instability, presence of delirium, endocrino-metabolic disease and polypharmacy proved to be independently associated with the falls (Evans et al., 2001; Oliver et al., 2004). The most frequent diagnosis reported in the endocrino-metabolic group was diabetes.

A recent review on risk factor for falls in hospital setting highlighted as strong predictors of falling: gait instability, lower limbs weakness, urinary incontinence, frequency or need for assisted toileting, previous fall history, agitation, confusion, impaired judgment and prescription of "culprit" drugs, in particular centrally acting sedative hypnotics (Oliver et al., 2004). In addition advanced age, sensorial impairments, various pathologies (anemia, neoplasms, congestive heart failure, stroke etc.), environmental and staffing characteristics etc. have also been linked to higher risk of falls in inpatients (Evans et al., 2001).

We found that fallers were older than non-fallers. This is probably due to the high prevalence of age related physiologic changes and of clinical diseases that rises with advancing age (Rubenstein and Josephson, 2006) and not to the chronologic age per se (Evans et al., 2001). In our patients' sample there was no difference between men and women, even if in previous reports (Tromp et al., 1998) being female was a predictor of falling in several settings.

Patients affected by diabetes and genito-urinary diseases fell more than patients without these pathologies, whereas no difference was found on CIRS scale. The diabetic old patient may be prone to falls for several reasons such as hypoglycemic syncope, impaired ambulation for neuropathy, peripheral arterial diseases, foot problems, orthostatic hypotension, side effects of diabetes medications (Krauss et al., 2005). The increased rate of falls associated with genito-urinary diseases, even if in our study this relationship loose strength in multivariate analysis, is due to special toileting needs (such as urgency and frequency) (Evans et al., 2001; King, 2003).

Although fallers scored lower on both balance and gait Tinetti's scale, after multivariate analysis only balance instability remained as an independent predictor of falling. Factors directly or indirectly related to mobility were identified as being associated with a greater risk of falling in several researches (Evans et al., 2001; King, 2003; Oliver et al., 2004; Vassallo et al., 2004). Delirious symptoms, as defined in the CAM scale, were also associated with superior

incidence of falls. Altered mental status namely confusion, agitation or cognitive impairment are commonly described in patients at high risk of falling (Oliver et al., 2004; Krauss et al., 2005).

We found that certain drugs (such as benzodiazepines, antidepressants, narcotics, calcium channel antagonists, diuretics and non-steroidal anti-inflammatory drugs) and the presence of polypharmacy were significantly associated to a higher number of falls and that polypharmacy is an independent predictor of falling. While previous data are contradictory, polypharmacy (and especially taking more psychoactive drugs) has commonly been assumed to lead to a greater risk of falls (Cumming, 1998; Leipzig et al., 1999a,b; Evans et al., 2001; Landi et al., 2005). As a consequence, regular reviews of patients' medications, minimizing the psychotropic drugs unless really necessary, may be an appropriate and costless fall prevention strategy.

Similarly to previous investigations fallers presented a prolonged LOS and a greater prevalence of nursing home placement after hospital discharge, with a worsened quality of life for the patients and an increased health care cost burden (Vassallo et al., 2002).

Some limitations of this study should be discussed. The sample of population investigated consisted of older patients admitted to an acute geriatric department of a university-teaching hospital; therefore our findings should not be generalized to patients hospitalized in other institutions. In addition, the study was not designed as a randomized controlled trial but is a longitudinal observational study.

5. Conclusion

Falls in hospitalized elderly patients occur as a result of multiple factors, knowledge of which could help in planning adequate preventive strategies. In our study advancing age, balance deficit, acute cognitive impairment, diabetes and polypharmacy were significantly and independently associated to falls. Programs for preventing hospital falls should target patients with these risk factors using scheduled mobilization and toileting, providing exercise and physical therapy interventions and minimizing the use of medications related to falling. Since hospitalization itself may represent a risk of falling, a careful evaluation of risk/benefit ratio is needed before deciding to hospitalize elderly patients, preferring a home based care setting (i.e., Home Hospitalization Services), whenever possible. Appropriate measures, as individualized and as well-timed as possible, that reduce the risk of falling will have a remarkably good influence on patients' global health status and on the overall cost of medical care.

Conflict of interest

The authors have no conflicts of interest to declare and certify that no founding has been received for the conduct of this study and/or preparation of this manuscript.

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