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HEALTHY AGING RESEARCH

# Risk factors for falls and their impact on the severity of fall-related injuries

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## Abstract

***Background:*** The aim of this work was to investigate risk factors for falls in a cohort of Austrian inpatients and assess the influence of fall risk factors on fall-related injuries.

***Methods:*** All fall protocols of an Austrian internal medicine department were evaluated over a 20-month period.

***Results:*** A total of 195 patients with a documented fall, and 195 age and sex-matched controls from the same unit were included in this study. Chronic heart failure, dementia and intake of more than one diuretic drug were associated with falls. Most falls occurred in the patient room and at night. Out of 195 falls, 79 (41%) were injurious with a moderate or severe post-fall injury in 6.7% of patients. None of the fall risk factors was associated with the severity of fall-related injury.

***Conclusions:*** This study confirms chronic heart failure, dementia, and intake of more than one diuretic drug as risk factors for falls in an Austrian internal medicine department. The grade of fall-related injuries was not related to the investigated fall-risk-factors.

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## Introduction

Falls of the elderly are a major concern for the individual as well as for the community. Approximately half of all elderly people over the age of 65 years experiences a fall every year, thereby causing about $20 billion dollars of healthcare costs in the US alone [1]. At present, diagnoses related to the central nervous, musculoskeletal and cardiovascular systems [2-3], and intake of drugs, especially anti-hypertensives, diuretics, anti-arrhythmics and anti-depressives [4], as well as polypharmacy [5], are considered as risk factors for falls in the elderly.

Screening for those elderly patients at increased risk for falls is of utmost importance in daily clinical practice. A variety of fall risk assessment tools is used in clinical practice [6]. However, as outlined in a recent literature analysis [7], these tests provide little or no clinically relevant information, and clinical judgement has still a higher degree of accuracy [8]. Thus, further analysis of risk factors and the implementation of risk assessment tools is necessary. Various fall prevention strategies including hip protectors, vitamin D supplementation, or correction of vision disorders have been applied, but most of these lead to inconsistent results [7]. Only exercise

intervention and modification of the housing environment have shown clear positive effects in fall prevention. When evaluating recommendations for fall prevention, the characteristics of the target population should be considered, since fall circumstances differ between hospitals [9] and even between departments [10].

In this retrospective study we evaluated nurse-based records for fall events in an Austrian department of internal medicine. Furthermore, we examined a possible association between fall risk factors and injurious falls.

## Methods

### Patients

This case-controlled study was conducted at the department of internal medicine of the general hospital of the Elisabethinen, Klagenfurt, which is a secondary care hospital in Southern Austria. Data from all consecutive patients with a documented fall during their hospital stay between May 2006 and March 2008 were included into this study, and were compared with randomly selected age and sex-matched inpatients without falls. Patients' data concerning diagnoses and current medications were retrospectively collected.

### Documentation of falls

Data about each individual patient's fall were recorded by a nurse-based reporting system. Location, time, footwear, and the grade of injury (ranging from no, mild, moderate to severe injury) were recorded. Mild injuries were defined as those not requiring medical treatment; moderate injuries summarized lacerations of the extremities and injuries of the head requiring computed tomography. Severe injuries included fractures and head lacerations.

### Statistical analysis

Statistical analyses were performed using the SPSS program, version 15.0 (Chicago, IL, USA). The parametric Student's *t*-test was used to compare quantitative variables between independent groups. The Chi-square test was performed to evaluate qualitative variables. A level of $p<0.05$ was considered to be statistically significant. The Bonferroni method was used to adjust for multiple testing.

## Results

In this study, a total of 195 patients with a fall were reported, representing 1.7% of all 11,812 inpatients within that time period. Patients with a fall were older (79.3 ± 10.3 years) compared to the mean age of all inpatients (63.7 ± 16.7 years, $p<0.01$). There was no association between sex and the occurrence of a fall.

### Environmental and patient-related risk factors

Most of the 195 falls occurred in the patient's room (150; 76.9%) and at night (117; 60%) (Table 1). Only 21.2% of daytime fallers and only 4.4% of night-time fallers were wearing stable footwear ($p<0.001$). Notably, 88 cases (45.1%) were equipped with a walking frame or a cane, but only 33 patients (16.9%) were using these assistance devices when the fall occurred. Seventy-one fallers (36.4%) wanted to get up, 58 (29.7%) intended to go to the toilet, 30 (15.4%) stumbled or slipped, 7 (3.6%) fell out of bed.

**Table 1.** Environment under which the fall events occurred

| | | ***n* (%)** |
|---|---|---|
| **Location** | | |
| | Corridor | 8 (4.1) |
| | Patient room | 150 (76.9) |
| | Toilet | 37 (19.0) |
| **Time of day** | | |
| | Morning | 38 (19.5) |
| | Afternoon | 40 (20.5) |
| | Night | 117 (60) |
| **Footwear** | | |
| | Stable (shoes) | 29 (14.9) |
| | Unstable (socks, slippers) | 123 (63.1) |
| | Barefoot | 43 (22) |

Data are given in numbers (*n*) with percentages in parentheses

Chronic heart failure (OR 2.2; 95% CI: 1.4-3.6) and dementia (OR 2.5; 95% CI: 1.5-4.3) were associated with falls ($p$<0.05; Table 2).

**Table 2.** Conditions of patients with a fall in comparison to case-controls (in alphabetical order)

| Patients' diagnosis | Fallers | Controls | Pcorr |
|---|---|---|---|
| Atrial fibrillation | 40 (20.5) | 34 (17.4) | n.s. |
| Chronic heart failure | 61 (31.3) | 33 (16.9) | 0.006 |
| Coronary artery disease | 34 (17.4) | 25 (12.8) | n.s. |
| Depression | 33 (16.9) | 16 (8.2) | n.s. |
| Dementia | 49 (25.1) | 23 (11.8) | 0.004 |
| History of stroke | 22 (11.3) | 12 (6.2) | n.s. |
| Parkinson | 13 (6.7) | 5 (2.6) | n.s. |

Data are given as absolute numbers with percentages in parentheses. *P*-values are calculated using the Chi-square test and are adjusted for multiple testing according to the Bonferroni correction.

### Diuretic medications as additional fall risk factors

The risk of falling was increased in those patients treated with more than one diuretic drug (OR 2.0, 95% CI: 1.2-3.4) (Table 3). The most frequently used diuretic drugs were furosemid ($n$=93), and hydrochlorothiazid ($n$=39).

### Lack of influence of fall-related risk factors on grade of injury

Fallers revealed mild injuries in 67 cases (34.4%). However, in eight cases (4.1%), moderate injuries (seven head injuries requiring computed tomography, one laceration) were reported, and in four cases (2.1%) there were severe injuries (two head lacerations, two hip fractures). There was no association concerning grade of injury and any other investigated parameter.

## Discussion

This is the first study on risk factors for falls and their influence on the severity of consequent injuries in a cohort of inpatients of an Austrian secondary care hospital.

A total of 195 fallers were reported in this hospital, representing 1.7% of all inpatients during that time period. Our data support previous reports, estimating a 2.2% rate of fallers during hospitalization [11].

**Table 3.** Medications of patients with a fall in comparison to case-controls (in alphabetical order)

| Patients' medication | Fallers | Controls | Pcorr |
|---|---|---|---|
| Amiodarone | 8 (4.1) | 5 (2.6) | n.s |
| Anti-depressives | 59 (30.3) | 39 (20.0) | n.s. |
| Benzodiazepines | 47 (24.1) | 44 (22.6) | n.s |
| Calcium and vitamin D | 42 (21.5) | 45 (23.1) | n.s |
| Digitalis | 22 (11.3) | 10 (5.1) | n.s. |
| Diuretics | 100 (51.3) | 118 (60.5) | n.s |
| Neuroleptics | 35 (17.9) | 22 (11.3) | n.s |
| Polypharmacy (>3 drugs) | 110 (56.4) | 127 (65.1) | n.s |
| Anti-hypertensives (>1 drug)* | 70 (35.9) | 49 (25.1) | n.s. |
| Diuretics (>1 drug) | 51 (26.2) | 2 (1.0) | 0.006 |

Data are given as absolute values with percentages. *P*-values are calculated using the Chi-square test and are adjusted for multiple testing according to the Bonferroni correction.

*anti-hypertensives except diuretic treatments

The majority of falls in our study happened at night, in the patient room with the patient intending to get up, or on the way to the toilet. The focus for fall prevention should be on that critical situation in which patients should be strongly advised to call for assistance. The importance of stable footwear has been addressed previously [12-13]. According to our results, stable footwear might be of special importance in the prevention of falls during the night, since almost all night fallers were barefoot or wearing stockings.

Dementia, chronic heart failure, and intake of more than one diuretic drug were associated with the occurrence of falls in our study population.

Dementia has previously been shown to be a risk factor for falls, but not for injury among fall events

[14], which is in line with our findings. In our study we did not find any association with stroke or Parkinson's disease, although this is well documented in previous reports [15-17]. We might have missed the association since these neurological conditions were underrepresented in our cohort of internal medicine inpatients. Chronic heart failure and the use of diuretics have been previously described as major fall risk factors in elderly patients [18-22], and were confirmed in our study cohort. Whether the causative mechanism for the association of heart insufficiency and the risk of falling is related to a malsupply of the brain, an impaired stability due to edema, or other consequences, is yet unclear. The risk of falling under treatment with diuretics might be additionally influenced by the evoked hyponatremia, a known side effect also associated with bone fractures after incidental falls in the ambulatory elderly [27].

We documented fractures in only two cases (~1% of patients with a fall), which is comparable with previous findings [23]. We did not detect any association between injuries and a specific disease condition or medication. In contrast to our findings, a Danish study detected a small increase of fracture risk in patients taking psychotropic drugs [24]. Heart failure is a risk factor for hip fractures according to the Cardiovascular Health Study [25]. The conflicting results demonstrate that risk factors for fall-related injuries are not generalizable across different patient populations [26]. This highlights the importance of investigating each setting separately in order to identify risk factors and to improve injury prevention.

Major limitations of this study are a small sample size and the retrospective design. Furthermore, data on bone density, nutrition status, frailty, previous falls, self-reliance, or tests on fall risk assessment were not included in the standardized fall reports and could not be retrieved retrospectively. We used the Chi-square test to analyze the risk of falling, thus probable interactions of the assessed risk factors were not considered.

## Conclusions

This study confirmed chronic heart failure, dementia, and the use of more than one diuretic as risk factors for falls in a cohort of inpatients. None of the investigated risk factors was associated with the grade of post-fall injury.

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## References

1. Chang JT, Morton SC, Rubenstein LZ, Mojica WA, Maglione M, Suttorp MJ, et al. Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. BMJ. 2004;328(7441):680.
2. Grisso JA, Kelsey JL, Strom BL, Chiu GY, Maislin G, O'Brien LA, et al. Risk factors for falls as a cause of hip fracture in women. The Northeast Hip Fracture Study Group. N Engl J Med. 1991;324(19):1326-31.
3. Sakuma M, Endo N. Muscle and bone health as a risk factor of fall among the elderly. Vitamin D for prevention of fall and fracture. Clin Calcium. 2008;18(6):816-20.
4. Leipzig RM, Cumming RG, Tinetti ME. Drugs and falls in older people: a systematic review and meta-analysis: II. Cardiac and analgesic drugs. J Am Geriatr Soc. 1999;47(1):40-50.
5. Corsinovi L, Bo M, Ricauda Aimonino N, Marinello R, Gariglio F, Marchetto C, et al. Predictors of falls and hospitalization outcomes in elderly patients admitted to an acute geriatric unit. Arch Gerontol Geriatr. 2009;49(1):142-5.
6. Wagner LM, Scott V, Silver M. Current approaches to fall risk assessment in nursing homes. Geriatr Nurs. 2011;32(4):238-44.
7. Balzer K, Bremer M, Schramm S, Luhmann D, Raspe H. Falls prevention for the elderly. GMS Health Technol Assess. 2012;8:Doc01.
8. Vassallo M, Poynter L, Sharma JC, Kwan J, Allen SC. Fall risk-assessment tools compared with clinical judgment: an evaluation in a rehabilitation ward. Age Ageing. 2008;37(3):277-81.
9. Krauss MJ, Nguyen SL, Dunagan WC, Birge S, Costantinou E, Johnson S, et al. Circumstances of patient falls and injuries in 9 hospitals in a midwestern healthcare system. Infect Control Hosp Epidemiol. 2007;28(5):544-50.
10. Schwendimann R, Buhler H, De Geest S, Milisen K. Characteristics of hospital inpatient falls across clinical departments. Gerontology. 2008;54(6):342-8.

11. Halfon P, Eggli Y, Van Melle G, Vagnair A. Risk of falls for hospitalized patients: a predictive model based on routinely available data. J Clin Epidemiol. 2001;54(12):1258-66.
12. Koepsell TD, Wolf ME, Buchner DM, Kukull WA, LaCroix AZ, Tencer AF, et al. Footwear style and risk of falls in older adults. J Am Geriatr Soc. 2004;52(9):1495-501.
13. Menz HB, Morris ME, Lord SR. Footwear characteristics and risk of indoor and outdoor falls in older people. Gerontology. 2006;52(3):174-80.
14. van Doorn C, Gruber-Baldini AL, Zimmerman S, Hebel JR, Port CL, Baumgarten M, et al. Dementia as a risk factor for falls and fall injuries among nursing home residents. J Am Geriatr Soc. 2003;51(9):1213-8.
15. Gray P, Hildebrand K. Fall risk factors in Parkinson's disease. J Neurosci Nurs. 2000;32(4):222-8.
16. Wood BH, Bilclough JA, Bowron A, Walker RW. Incidence and prediction of falls in Parkinson's disease: a prospective multidisciplinary study. J Neurol Neurosurg Psychiatry. 2002;72(6):721-5.
17. Weerdesteyn V, de Niet M, van Duijnhoven HJ, Geurts AC. Falls in individuals with stroke. J Rehabil Res Dev. 2008;45(8):1195-213.
18. French DD, Campbell R, Spehar A, Cunningham F, Bulat T, Luther SL. Drugs and falls in community-dwelling older people: a national veterans study. Clin Ther. 2006;28(4):619-30.
19. Gerber Y, Melton LJ 3rd, Weston SA, Roger VL. Osteoporotic fractures and heart failure in the community. Am J Med. 2011;124(5):418-25.
20. Lloyd BD, Williamson DA, Singh NA, Hansen RD, Diamond TH, Finnegan TP, et al. Recurrent and injurious falls in the year following hip fracture: a prospective study of incidence and risk factors from the Sarcopenia and Hip Fracture study. J Gerontol A Biol Sci Med Sci. 2009;64(5):599-609.
21. Tanaka M, Suemaru K, Ikegawa Y, Tabuchi N, Araki H. Relationship between the risk of falling and drugs in an academic hospital. Yakugaku Zasshi. 2008;128(9):1355-61.
22. Tevendale E, Baxter J. Heart failure comorbidities at the end of life. Curr Opin Support Palliat Care. 2011;5(4):322-6.
23. Healey F, Scobie S, Oliver D, Pryce A, Thomson R, Glampson B. Falls in English and Welsh hospitals: a national observational study based on retrospective analysis of 12 months of patient safety incident reports. Qual Saf Health Care. 2008;17(6):424-30.
24. Vestergaard P, Rejnmark L, Mosekilde L. Anxiolytics, sedatives, antidepressants, neuroleptics and the risk of fracture. Osteoporos Int. 2006;17(6):807-16.
25. Carbone L, Buzkova P, Fink HA, Lee JS, Chen Z, Ahmed A, et al. Hip fractures and heart failure: findings from the Cardiovascular Health Study. Eur Heart J. 2010;31(1):77-84.
26. Mion LC, Chandler AM, Waters TM, Dietrich MS, Kessler LA, Miller ST, et al. Is it possible to identify risks for injurious falls in hospitalized patients? Jt Comm J Qual Patient Saf. 2012;38(9):408-13.