

Characteristics associated with falls in patients with dementia in a psychogeriatric ward

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ABSTRACT. Background and aims: Few studies have reported fall-risk factors for persons with dementia, and no successful randomized fall prevention studies have been published. The aim of this study was to identify characteristics associated with falls in patients with dementia in a psychogeriatric ward. **Methods:** This prospective study comprised 204 patients with any diagnosis of dementia. It was carried out in a psychogeriatric ward specializing in the assessment and treatment of behavioral and psychological symptoms in patients with dementia (BPSD). Baseline patient data were collected from medical records, and covered physical, behavioral and cognitive areas. Falls were recorded during time spent in the ward and median follow-up time was 52.5 days. **Results:** Eighty-two patients fell a total of 251 times. Factors significantly and independently associated with an increased risk of falling were male sex (IRR 3.36, 95% CI 2.02–5.61), failed “copy design” activity (decreased visual perception) (IRR 2.37, 95% CI 1.24–4.52), and any walking difficulty on level ground (IRR 1.84, 95% CI 1.10–3.08). Statins were associated with a decreased risk of falling (IRR 0.29, 95% CI 0.10–0.86). Twenty-seven percent of the variation in falls was explained. **Conclusions:** Male sex, decreased visual perception, and walking difficulties were all associated with an increased number of falls, and the model explained 1/4 of the variation in falls. Well-planned furnishing and use of color to achieve a plain, clearly defined environment, as well as training in walking ability, may decrease the risk of falling in people with dementia.

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INTRODUCTION

Falls and their consequences are a major health problem among the older population, and the problem is

even greater among people with cognitive impairment and dementia. The risk of falling is higher among people with dementia (1-5) and correspondingly high fracture rates have also been reported (6). Post-operative complications and mortality (7) after hip fracture are also higher among people with dementia. The average costs for one hip fracture are substantial, and thus people with dementia are an important group from the preventive point of view. The prevalence of dementia increases rapidly with age and, because of demographic development, the proportion of people with dementia will also increase.

Several studies have shown that falls and injuries among certain groups of older people can be prevented with a multi-factorial intervention program (8). People with low cognitive function are often either excluded or not presented separately in these studies, and the few attempts that have been made to address the issue of falls in people with dementia show no significant results (9, 10). This lack of positive results may stem from copying interventions that have previously been applied to an older population in general. We believe there are joint fall-risk factors for people with and without dementia, as well as specific fall-risk factors for people with dementia. Thus, it is necessary to increase the bulk of knowledge concerning falls among people with dementia.

The aim of this study was to identify characteristics associated with falls in patients with dementia in a psychogeriatric ward.

METHODS

Participants

The study was performed in the psychogeriatric ward at Umeå University hospital. This 24-bed ward specializes in the assessment and treatment of cognitive impairment, with a focus on behavioral and psychological symptoms in patients with dementia (BPSD). Patients

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Key words: Accidental falls, dementia, male sex, risk factors, visual perception, walking ability.

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Table 1 - Characteristics of participants on admission.

Participants	n* = 204
Age (years), mean±SD	78.7±7.4
Male, n† (%)	78 (38)
Living condition	
Ordinary housing (n=203), n (%)	155 (76)
Residential care facility (n=203), n (%)	48 (24)
Walking ability on level ground (n=202)	
Walking without walking aid, n (%)	128 (63)
Walking difficulties, n‡ (%)	74 (37)
MMSE score (n=150), mean±SD	16.7±6.2
BEHAVE-AD score (n=190), mean±SD	8.5±6.0
FAST score (n=192), mean±SD	7.6±2.2
Number of medications, mean±SD	6.4±3.7

n*: number of participants with available data for each variable, when no data are missing, n=204. †n: Number of participants featuring characteristics of specific variable. ‡Five of 74 patients with walking difficulties were bedridden.

with any diagnosis of dementia present in the ward from September 1 2001 to August 31 2003 were included in the study. Thirty-seven patients were not included, either because they did not fulfil the criteria for dementia or were admitted to the ward more than two months prior to the study onset. A total of 204 patients, 126 (61.8%) women and 78 (38.2%) men aged between 56 and 94, with a mean age±SD of 78.7±7.4 years, were included in the study (Table 1).

Data collection

Baseline patient data were collected from medical records. Data from assessments performed during the two first weeks after admission were mainly used in the analyses. Falls were recorded during the time spent in the ward. Observation days per patient were in median 52.5 days, 10th to 90th percentiles, 16 to 161 days. The total number of observation days was 14686.

Patients admitted to our psychogeriatric department routinely underwent a comprehensive geriatric assessment that included physical and behavioral assessment, and laboratory tests to detect diseases that may contribute to the symptoms and complications of dementia. Behavior was observed by both geriatricians and staff, and discussed by a team. Patients' dementia diagnoses were classified according to DSM-IV criteria. The systematic assessment of the patients include the measurements presented below.

Functional capability was assessed by the Functional Assessment Staging Scale (FAST) and by scoring the ability to walk. FAST was developed to assess functional level in people with dementia (11). It includes 16 stages, from 1 to 7f. The first stages deal with more complex tasks (forgetting the location of objects, decreased work capacity) and the latter with bodily functions (non-ambula-

tory, unable to hold head up). In our study, information was gathered by a multidisciplinary team and, from the type of problems described, it was decided which stage fitted the person best. Walking ability was scored either by a physiotherapist on a two-grade scale or interpreted from the medical records according to the same scale (on level ground: "can walk independently without walking aid" versus any walking difficulty, from "can walk with walking aid" to "cannot walk").

Cognitive function was rated with the Mini-Mental State Examination (MMSE), with the maximum score 30 indicating no cognitive difficulties. When planning the study, we hypothesized that visuo-perceptual ability, attention, and concentration were abilities of special interest in relation to falls. These areas were considered to be assessed by the items "copy design" and "attention and calculation" of the MMSE. "Copy design" involves the copying of two intersecting pentagons.

Behavioral symptoms were rated with BEHAVE-AD, which is a scale designed to rate behavioral symptoms in patients with Alzheimer's disease (12). The items covered are: paranoid and delusional ideation, hallucination, activity disturbances, aggressiveness, diurnal rhythm disturbances, affective disturbances, and anxieties/phobias. BEHAVE-AD was rated by a multidisciplinary team based on clinical observations.

Laboratory tests of serum included glucose (4.2-6.3 mmol/L), albumin (36.6-48.2 g/L), homocystein (≤ 0.15 μ mol/L), sodium (134-148 mmol/L), potassium (3.4-5.0 mmol/L), creatinin (58-109 μ mol/L), thyroid-stimulating hormone (0.28-4.5 mIU/L), and also blood hemoglobin (132-168 for men, and 125-158 g/L for women), with normal values in brackets.

Any use of medication on the day of admission to the ward was recorded. All on-demand medication was treated as absence of medication.

A fall report form, developed by the research team and staff at the ward, was used for staff registration of falls. To further improve the reporting of falls, the patients' medical records were reviewed. Fifty-one (20%) of all 251 falls were found in this way. A fall was defined as any event leading to the person unintentionally ending up on the ground or floor, irrespective of the reason and regardless of whether any injury was sustained. Thus, falls induced by acute illness or pushes were also included, as well as when the staff found the patient on the floor. Most falls were reported by the staff, but occasionally a fall was reported by the patient who fell or by another patient. In these cases, the staff reviewed the accuracy of the reported fall on the basis of clinical knowledge of the patient and traces of a fall, such as a detectable injury. Injuries were divided into minor injuries (visible wounds) and fractures.

The study was approved by the local ethics committee of the medical faculty of Umeå University, dnr 03-391.

Statistical analyses

Fall rate (fall/person year, PY) for probable risk factors for falls was calculated through multiplication of sum of falls for this factor by days in the year (365.25), divided by the number of observation days for the same factor.

Possible differences in the risk of sustaining a fracture between patients who fell once and those who fell more than once were analyzed with the χ^2 test. The same test was also used for associations between not being able to go back home to ordinary housing, living with a partner at the time of admission to the ward, and being involved in a fall. χ^2 analyses were carried out by SPSS 11.0.

To detect factors associated with falls, incidence rate ratios (IRR) were calculated using Poisson regression analyses, with adjustment for over-dispersion of falls (negative binomial regression) (Stata software 8.0). This method

takes into account the different duration of time spent in the ward and the possibility of multiple falls per resident. First, probable risk factors were analyzed one by one. To find the independent factors which would best explain the variation in falls, factors with a p -value <0.15 in the univariate analyses were tested by establishing a Poisson regression model. For factors correlating with each other, the factor which contributed the most was chosen. Adjustments were made for the FAST score. A p -value of <0.05 was regarded as statistically significant.

Some items of the MMSE (copy design, attention and calculation) and the BEHAVE-AD (diurnal rhythm disturbances, activity disturbances) apart from the scale as a whole, were considered to be of interest in relation to falls by themselves. The MMSE item "attention and calculation" was dichotomized between one attempt and at

Table 2 - Possible factors associated to falls, univariate analyses, $n^*=204$.

	Number of patients > 0 falls	Number of falls	Falls/PY [‡]	IRR [§]	95% CI [∞]
Male sex, $n^{\dagger} = 78$	41	157	12.9	3.59	2.17-5.96
RATINGS AND MEASUREMENTS					
Walking difficulties, $n=202$, $n=74$	37	127	10.9	2.09	1.21-3.61
MMSE					
Failed copy design, with imputation, $n=198$, $n=150$	71	222	7.8	4.28	2.16-8.48
Failed copy design, without imputation, $n=146$, $n=104$	47	115	6.0	3.37	1.61-7.05
Failed attention and calculation, $n=147$, $n=76$	31	71	5.2	1.54	0.80-2.95
BEHAVE-AD, $n=190$					
Activity disturbances, $n=57$	32	122	9.4	2.38	1.34-4.26
Diurnal rhythm disturbances, $n=87$	47	156	8.8	2.00	1.15-3.50
DIAGNOSES					
Dementia, $n=207$					
Alzheimer's disease, $n=94$	34	91	4.2	0.60	0.35-1.04
Vascular dementia, $n=50$	23	72	9.0	1.22	0.65-2.29
Alzheimer's disease with cerebrovascular lesion, $n=11$	6	34	13.3	2.66	0.92-7.72
Frontotemporal dementia, $n=12$	4	7	2.6	0.36	0.10-1.30
Lewy body dementia, $n=21$	12	42	11.3	1.89	0.83-4.30
Alcoholic dementia, $n=7$	3	8	6.4	0.91	0.20-4.10
Unspecified dementia, $n=10$	1	1	1.0	0.17	0.02-1.67
General diagnoses and signs					
Previous stroke, $n=50$	21	62	7.0	1.23	0.65-2.31
Diabetes mellitus, $n=25$	14	54	10.0	1.84	0.86-3.95
Constipation, $n=53$	29	89	8.7	1.58	0.87-2.88
Atrial fibrillation, $n=20$	11	55	15.3	2.05	0.91-4.07
Urinary infection on admission to ward, $n=139$, $n=31$	13	56	8.0	0.93	0.45-1.90
MEDICATION					
Diuretics, $n=63$	32	109	10.3	1.70	0.97-3.00
Beta-receptor blockers, $n=60$	18	43	3.8	0.50	0.27-0.92
Analgesics, $n=120$	57	151	7.4	1.63	0.94-2.81
Laxatives, $n=48$	27	65	6.8	1.39	0.74-2.63
Antidepressants, $n=84$	34	84	6.0	0.96	0.55-1.68
Benzodiazepines, $n=77$	33	104	7.1	1.20	0.69-2.08
Clomethiazole, $n=28$	19	84	15.3	2.63	1.31-5.29
Neuroleptics, $n=94$	40	136	7.6	1.36	0.79-2.34
Acetylcholinesterase inhibitors, $n=56$	21	84	6.9	1.25	0.69-2.27
Statins, $n=19$	4	6	1.8	0.25	0.08-0.78
Folic acid, $n=91$	37	79	4.5	0.58	0.33-0.99
B12, $n=98$	43	105	5.7	0.85	0.50-1.47

n^* : Number of participants with available data for the relevant variable, when no data are missing, $n=204$. Only deviations from 204 are shown beside the variable. In the case of dementia diagnoses n is 207, because of three patients with 2 diagnoses each. n^{\dagger} : Number of participants featuring characteristics of specific variable. ‡ Person year. § Incidence rate ratio. $^{\infty}$ Confidence interval.

least two successful attempts to subtract 7 from 100. In the item "copy design", 52 values were imputed because of missing data. The imputed values were decided on the basis of the FAST values. Most patients (87%) with FAST values between 6c and 7f, indicating a low functional level, who also had a score on the item "copy design", had failed the copying task. The proportion of patients with FAST values between 4 and 6b and values on the item "copy design" that failed to copy was smaller (59%). Accordingly, we chose to impute "failed" instead of the 40 missing values on copying for patients with FAST values between 6c and 7f. The 12 missing copy values corresponding to FAST values between 4 and 6b were randomized as either failing or succeeding. Six patients had neither FAST nor copying values and, in these cases, no imputation was made.

The item "diurnal rhythm disturbances" of the BEHAVE-AD is scored 0 to 3. It was dichotomized between 0 and 1, which means at least repetitive awakenings at night. The item "activity disturbances" consists of 3 items, each scored 0 to 3, and thus the maximum score is 9. It was dichotomized between 2 and 3, which means at least two types of activity disturbances, or one type of activity disturbance to a degree sufficient to require restraint.

To be able to use the FAST scale in statistical calculations, FAST was transformed from a categorical scale, 1-7f, to a numerical scale, 1-16, i.e., the different stages were given numbers instead of numbers and letters.

The laboratory test values were transformed to binary variables: normal and pathological.

RESULTS

Falls and their consequences

Eighty-two out of 204 patients (40%) fell, in all, 251 times. The fall rate was 6.2 falls/person year (3.4 for women, 12.9 for men). Forty-six patients fell more than once, and they contributed with 215 falls altogether. A maximum of 21 falls was recorded for one single patient.

Six percent of the 251 falls resulted in 14 fractures in 13 patients: eight hip fractures, one skull base fracture, two fractures each of pelvis and costae, and one elbow fracture. Two of these fractures resulted in death within 6 weeks. Of the remaining falls, 27 patients suffered from 31 visible minor injuries, such as scratches and bruises. The risk of sustaining a fracture because of a fall did not differ between patients who fell once compared with patients who fell twice or more (17.4% vs 13.9%, $p=0.667$). There was a tendency for patients who fell in the ward having less chance of returning to ordinary housing than those who did not fall (18.2% vs 32.7%, $p=0.054$).

Risk factors for falls

The univariate analyses show that male sex and a failure of copy design on the MMSE was associated with falls (Table 2). Living with a partner at the time of ad-

mission and decreased walking ability were also related to falls. Likewise, functional level determined by FAST (IRR=1.27, 95% CI 1.12-1.44), cognitive level determined by MMSE (IRR=1.06, 95% CI 1.01-1.11), behavioral problems determined by BEHAVE-AD (IRR=1.05, 95% CI 1.004-1.10), and the subcategories of BEHAVE-AD "activity disturbances" and "diurnal rhythm disturbances" were all associated with falls. None of the various dementia diagnoses were significantly related to falls. The drugs Clomethiazole, Haloperidol, and the whole group of analgesics were associated with an increased risk of falling, while the opposite was the case for beta-receptor blockers, statins and folic acid. Antidepressants showed no connection with falls, and neither did the number of prescribed drugs (IRR=1.02, CI 0.95-1.09).

A multivariate Poisson regression model is presented in Table 3. Factors significantly and independently associated with an increased risk of falling were male sex, failed copying, and walking difficulty. Analyses of failed copying without imputation did not change the result. Treatment with statins was associated with a decreased risk of falling. The model was adjusted for functional level by FAST, and explained variations in falls with an adjusted R square of 0.268.

Further analyses were carried out to find possible confounders to the factors male sex and statins. Men and women differed in a number of variables such as delirium, epilepsy, Parkinson's disease, BEHAVE-AD, MMSE, Lewy body dementia and intake of Haloperidol. A Poisson regression model containing these variables and sex did not alter the sex variable. Among statin users, an overrepresentation of diseases and medications related to the cardiovascular area was found together with high plasma homocystein levels. Failure of attention and calculation was less common in the group of statin users. A Poisson regression model including statins and medications and diseases related to the cardiovascular area as independent variables did not change the result of statin use. In two different Poisson regression models, including statins and one of the two variables, plasma homocystein

Table 3 - Multivariate analysis showing factors independently associated to falls, $n=190$.

	p-value	IRR*	95% CI
Male sex	0.000	3.36	2.02-5.61
Failed copying, with imputation	0.009	2.37	1.24-4.52
Walking difficulties	0.020	1.84	1.10-3.08
Treatment with statins	0.026	0.29	0.10-0.86
FAST as numeric scale	0.124	1.10	0.97-1.24

R² =0.268; *Incidence rate ratio.

or attention and calculation, the confidence intervals of statins did cross one. In these two models, the number of patients receiving statins was between 12 and 15.

DISCUSSION

This study confirms the picture of people with dementia as being prone to fall. The main characteristics contributing to these falls were male sex, decreased visual perception, and decreased walking ability. However, in this group of people with dementia in a psychogeriatric ward, only a small part of the variations in falls could be explained by these risk factors.

In the present study, the fall rate was 6.2 falls/PY, which is in the top end when compared with similar groups of people (4.1-6.3 falls/PY) (2, 13, 14). This position should be viewed in the light of the combination of being to a large extent ambulatory and having a large extent of additional complications related to dementia.

We found that men fell more often than women. In samples similar to ours, a mixed sample of people with dementia, others have come to the same conclusion (13, 14). However, in previous studies including persons with Lewy body dementia and Alzheimer's disease (AD) no gender difference was shown (15, 16), except in a subgroup analysis of persons with AD. That analysis showed that women were more prone to falls (16). Concerning men's possibly increased disposition to fall, it has been speculated that men under hospital care display more risky behavior or tend to be relatively more frail (14). Among non-demented men already at risk owing to decreased physical ability, a tendency to show a more risk-taking behavior has been associated with a higher risk of sustaining multiple falls (17). It has also been suggested that younger men, in contrast to women, cope with fear of failure and suppression of distress with, among other things, risk-taking behavior (18). In our investigation, men's predisposition to fall persisted, in spite of adjustment for variables suggesting that men are more frail. Thus, it is possible that increased risk-taking behavior among men with dementia predisposes them to fall.

We found that failure to copy design was a factor associated with falls among people with dementia. Others have speculated that visuospatial disability may be one cause of falls among people with dementia (19). Several forms of links between falls and decreased visual perception have been seen in stroke patients (20) and in rehabilitation patients with various diagnoses (21). Stroke patients with decreased visual perception describe problems such as judging distance to objects, deciding the range of objects, and discriminating between objects (22). These problems may affect obstacle clearance and thereby be linked with falls. However, among healthy older adults walking in a gait laboratory, no association was found between obstacle clearance and level of visual per-

ception (23); perhaps the threshold level was not reached, or decreased visual perception alone is not enough (21). Evidence suggests that a decline in visual perception is common among people with various types of dementia (24-26). We used the "copy design" item from MMSE as a measure of visual perception. A visuocstructional test like copy design involves components of visual perception and motor skill. Since copying pentagons is a relatively simple task involving motor skill and does not involve a time component, it may be argued that it is a relatively good test of visual perception.

In our analysis, we found that decreased walking ability was associated with an increased risk of falling. This is consistent with the findings of others who, in people with cognitive impairment and dementia, have seen associations between falls and various forms of decreased physical performance such as general physical disability (13), walking abnormalities (27), decreased muscle strength (6) and impaired balance, especially in the form of tandem gait (6, 16). Conflicting findings exist, but unfortunately no further analysis of it is possible, since the authors do not state how posture and gait were assessed (15). Evidence suggests that, already at the stage of mild cognitive impairment, over-representation of various forms of decreased motor control occurs, for instance: balance, motor speed, fine motor tasks, and more complex motor tasks (28). These impairments in motor performance have been attributed to a decline in higher-order CNS functions (29).

Our result of decreased fall risk in people taking statins should be viewed with caution, since the study design makes selection bias a possibility. Variables related to cardiovascular disease did not confound the results of statin use, but, since we had no data, we could not control for arteriosclerosis and blood lipid status. The variables plasma homocystein and attention and calculation were possible confounders to the results of statin use. One plausible explanation of our finding of a decreased fall risk among statin users was the cerebral protective effect. Statins are believed to reduce the risk of sustaining a thrombo-embolic stroke, as well as protecting the brain during states of compromised blood flow (30). An existing, but criticized, hypothesis postulates that statins have a beneficial effect on bone formation (31). Interestingly, the authors could not explain the lower fracture rate among statin users as due to a corresponding increase in bone mineral density. Unfortunately, falls were not reported in that study (31). In addition to selection bias, the numerous univariate analyses of medications increase the risk of a type 1 error.

We found that people who fell only once and those who fell twice or more did not differ with regard to the risk of sustaining a fracture, indicating that it is important to identify people who are prone to fall as soon as possible – ideally before their first fall.

Although we found some interesting results that con-

tribute to the growing base of knowledge concerning falls among people with dementia, we could only explain 27% of the variation in falls. The present study probably overlooked both known and unknown factors influencing a person's ability to maintain equilibrium. Impaired vision and vertigo are both examples of characteristics not considered here, in spite of the fact that they have been shown to be connected with falls in other contexts. There is also reason to believe that a measure of discrepancy between patient-perceived capacity and actual capacity to perform a task properly could be an important point to be considered in people with dementia (27, 32). This phenomenon is suspiciously similar to the risk behavior we proposed as an explanation for men being more prone to falls.

Many of our patients were affected with some kind of behavioral problem. The concomitant large distribution of behavioral problems makes it likely that a relationship between any kind of such problems and falls would have been detected. Instead, generalizations from this sample must be made with caution, since it was not representative of people with dementia in general. One limitation of this study is that background characteristics present at the moment of admission to the ward may have changed owing to treatment strategy or fluctuation of the disease – regarding, for instance, the use of psychotropic medications, behavioral syndromes and delirium, respectively. The exploration of a connection between psychotropic medications and falls among people with dementia should continue, since an association has been shown in other contexts (33). Although we did not find any association between delirium and falls, others have done so (6). Another limitation is that we did not make any attempt to include acute illnesses or drug side-effects which, in an already frail population, probably elicit a non-negligible number of falls. One way of handling the problem of changing background factors would be repeated re-evaluation of possible fall risk characteristics. Interpretation of walking difficulties as a risk factor should be made with caution, since gait and balance were not evaluated with a formal test.

The conclusion of the present study is that, among people with dementia in a psychogeriatric ward, male sex, decreased visual perception, and walking difficulties were all associated with an increased risk of falling, but explained only a small part of the variations in falls. Regarding walking difficulties, there is evidence of improvements in parts of the complex system involved in walking, such as strength and flexibility, if suitable exercises are used (34). We also believe that people with decreased visual perception would benefit from a plain, clearly defined environment, and working with colors may be one way of accomplishing this goal (22). The features of male sex and the possibility of statins influencing the risk of falling are topics for future research.

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