Falls in hospital: a case–control study

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Aims: Falls among inpatients are common. The method used by The Norwegian Patient Safety Campaign to measure the adverse events is the Global Trigger Tool, which does not look at the causation for falls. This study was aimed at investigating major risk factors for falls in the hospital setting.

Methods: This retrospective case–control study was conducted at Telemark Hospital in Norway, in the period from September 2012 to August 2014. A total of 842 patients from three wards were included, whereof 172 cases had experienced one or more fall(s) during hospitalisation and 670 random controls had not fallen. Data were analysed according to a pragmatic strategy.

Results: Compared with patients who did not fall, patients who fell were 21 times more likely to have poor balance (OR = 21.50, 95% CI: 10.26–45.04) and 19 times more likely to have very poor balance (OR = 19.62, 95% CI: 9.55–40.27), twice as likely to be men (OR = 1.82, 95% CI: 1.24–2.68), and 50% increased probability of fall with every 10 year increase of age (OR = 1.51, 95% CI: 1.34–1.69). Furthermore, the patients who fell were more likely to use antidepressant drugs (OR = 3.85, 95% CI: 1.09–13.63), antipsychotic drugs (OR = 3.27, 95% CI: 1.94–5.51), anxiolytic/hypnotic drugs (OR = 1.80, 95% CI: 1.22–2.67) and antiepileptic drugs (OR = 1.13, 95% CI: 1.11–4.06) than patients who did not fall.

Conclusions: During hospital stay, patients who fell had a higher risk profile than patients who did not fall. Clinicians should work to improve patients’ safety and reduce the risk of falls by accurately assessing balance and mobility as a form of primary prevention. We recommend that a review of the patient medications should be conducted upon falling, as a form of a secondary preventive strategy against falls.

Keywords: falls, drugs, antidepressants, hospital, balance.

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Introduction

Falls among inpatients are common, and the incidence varies from 3, 4 cases per bed annually in the acute rehabilitation of stroke patients to an average fall rate of 4.8 falls per 1000 patient days in acute hospitals (1,2). Falls in the elderly may cause loss of independence, injuries and sometimes death as a result of the injury (3). In 2017, falls accounted for 13.7% of all adverse events reported from Norwegian hospitals (4). Most frequent were falls due to loss of balance, falls out of bed or in connection with going to the toilet (4). Risk factors for falls are well documented (5). Still, there is inconclusive evidence for the effectiveness of most preventive strategies (1,6). There is evidence that multifactorial interventions reduce falls in hospitals, although subgroup analysis suggests this may apply mostly to a subacute setting, but the evidence for risk of falling was uncertain (3). Effective interventions are important to detect, because they will have significant health benefits for older people.

In 2012, Telemark Hospital was selected to be a pilot project in the Norwegian Patient Safety Program, ‘In safe hands,’ and therefore started the registration of all accidental falls (7). In a two-year period, 172 falls were registered in three hospital wards (Neurology, Respiratory medicine and Acute Geriatric medicine). The hospital quality assurance register suggested that these three wards had the highest number of falls registered among elderly patients between the ages of 76 and 85 years. An earlier study demonstrated an extensive use of drugs given in hospitals, where the average drug consumption was over seven drugs per patient (8). Central nervous system (CNS) active drugs, such as neuroleptics, benzodiazepines and antidepressants, appear to be the most common drugs associated with falls (5). It is claimed that the
use of drugs is one of the most modifiable fall risks in hospital (5). Based on this evidence, one might assume that a medication review is a key factor to preventing falls in the acute hospital setting. It may, however, prove difficult to change a patient’s medication in the hospital setting. An Irish study from 2014 demonstrated a higher possibility for change of on-demand drugs as compared with regular medication (9).

From 2010 to 2012, the proportion of adverse events reported from Norwegian hospitals decreased from 16 to 13.9% at the national level (10). Since then, the proportions have been stable, but the risk of moderately serious patient injury has probably increased (10). The method used to measure these numbers is the Global Trigger Tool, which does not look at the causation between these adverse events (10). By improving our knowledge about today’s clinical situation, we will have a better understanding of how to weigh interventions in order to reduce the number of falls. Therefore, we see the need for more knowledge with regard to clinical practice in relation to evidence-based practice. Consequently, this study was aimed at investigating which major risk factors had the strongest association with the falls that have occurred.

**Material and methods**

A retrospective case–control study was conducted at Telemark Hospital in Norway. Eligible for inclusion were adults, 18 years or older, admitted to the hospital from September 2012 to August 2014. Participants were recruited from three wards: Neurology, Respiratory medicine and Acute Geriatric medicine. From the total number of patients admitted to these three wards during the study period (source population), we included all the patients registered with one or more falls (cases) during hospitalisation and a random sample of patients who did not fall (controls). The procedure of random controls was to remove 172 cases from the total 5957 patients at the three wards during the study period leaving 5785 not to fall (controls). The procedure of random controls was performed with regular medication (9).

To estimate the number of controls needed for each ward. The random sample was generated in **Stata** version 11.0 (Statacorp, College Station, TX, USA) with sampling fractions at the Respiratory medicine ward, the Neurology ward and the Acute Geriatric medicine ward of 11.7, 11.7 and 11.9%, respectively.

Fall was defined as ‘an event resulting in a person coming to rest inadvertently on the ground, floor or other lower level, whether there is any damage caused by the fall’ (7). The major risk factors for falls were considered most relevant for an acute hospital setting based on the earlier mentioned pilot project. These factors include age, sex, balance, chronic diseases, renal function and drugs. Increased inpatient fall risk has been associated with older age and poor health status (1), and therefore, the diagnosis and the number of chronic diseases were registered. Patients with previous history of falls, reduced balance and poor gait are at an increased risk for future falls (11). The information on balance was clinically assessed to be either of good balance (patient was able to walk without a walking aid), or of poor balance (patient was walking unsteadily but had no documented walking aid) or of very poor balance (patient was walking unsteadily and had a documented walking aid). Patients with poor renal function are less able to excrete drugs. Rowe (12) cited in Rochon (13) claims that decreased drug clearance may also result from the natural decline in renal function with age, even in the absence of renal disease. This increases the risk that the patient is being exposed to a higher dosage of the drug, as compared to a patient with normal renal function (14). The renal function was measured as good (glomerular filtration rate (GFR) >60), moderate (GFR 30–60) or poor (GFR <30). Polypharmacy is also a known risk factor associated with falls (13). Each medication was therefore registered upon admission, during hospital stay and at discharge. The following six CNS active drug groups were considered potential risk factors for falls: antidepressants, cardiovascular and antihypertensives, opioids, antiepileptics, antipsychotics, and anxiolytic and hypnotic drugs.

Registration of patient data was based on information from (1) the pilot project, (2) the hospital’s safety system Total Quality Management (TQM) and (3) the patient’s medical records. A case report form (CRF) was developed and a database built in **EpiData Entry** version 3.1 (The Epi-Data Association, att. Jens Lauritsen, Denmark, Europe).

Sample size estimation was performed considering antidepressant drugs as a potential risk factor for falls. Based on an estimated prevalence of antidepressant use among stroke patients of 50% (15) and users being 1.68 times more likely to fall compared with non-users (16), we would need a minimum of 167 cases and 668 controls considering four controls per case, a type I error of 5% and power of 80%.

We analysed the data according to a pragmatic strategy, which means that the priority was not given to a specific hypothesis. The association between potential risk factors and falls was quantified by the odds ratio (OR) and its 95% confidence interval (CI). We explored the importance of patients’ age by stratifying age according to the 25, 50 and 75% percentiles, and estimated the association and gradient effect of each risk factor along the four age groups by a chi-square test for trend. To identify the independent risk factors for falls, we performed a manual backward stepwise elimination procedure using the logistic regression model (22). Multivariable analyses were preceded by the estimation of correlations between variables. The criteria for
Results

A total of 842 patients were included in the study, whereof 172 fallers (cases) and 670 nonfallers (controls). The clinical profile and the distribution of potential risk factors are presented in Table 1. Compared with controls, cases were 12 years older (median age 78 vs. 66), more frequently males (58.7% vs. 46.7%), with poor balance (39.0% vs. 15.5%) or very poor balance (54.1% vs. 23.7%), having multiple chronic diseases (60.5% vs. 50.1%) and getting problems. Model A shows that the patients who fell had 21 times (OR = 21.50, 95% CI: 10.26–45.04) the prevalence of poor balance and 19 times (OR = 19.62, 95% CI: 9.55–40.27) the prevalence of very poor balance as compared to the patients who did not fall. Furthermore, this group was twice as likely to consist of men (OR = 1.82, 95% CI: 1.24–2.68), and using/receiving the following drugs: anxiolytic/hypnotic drugs (OR = 3.73, 95% CI: 1.94–5.17), antiepileptic drugs (OR = 2.01, 95% CI: 1.15–3.51). Model B informs us that the probability of falling increased with 50% with every 10-year increase of age (OR = 1.51, 95% CI: 1.34–1.69). Furthermore, the patients who fell used three times more antipsychotics (OR = 3.27, 95% CI: 1.94–5.51) and antidepressant drugs (OR = 3.85, 95% CI: 1.09–13.63) than the patients who

| Table 1 Clinical profile of patients with fall (cases) vs. no fall (controls) |
|----------------------------------|-----------------|------------------|------------------|
|                                  | Casesn = 172 (%)| Controlsn = 670 (%)| OR (95% CI) p-Value |
| Age in years, median (IQR)       | 78 (68–85)      | 66 (49–79)        | 1.62 (1.16–2.28) 0.001 |
| Men                              | 101 (58.7)      | 313 (46.7)        | (reference)       |
| Balance*                         |                 |                  |                  |
| Good                             | 9 (5.2)         | 353 (52.7)        | (reference)       |
| Poor                             | 67 (39.0)       | 104 (15.5)        | 25.27 (12.18–52.40) 0.001 |
| Very poor                        | 93 (54.1)       | 159 (23.7)        | 22.94 (11.29–46.63) 0.001 |
| Poor renal function              | 47 (27.3)       | 189 (28.2)        | 0.96 (0.66–1.39) 0.818 |
| Multiple chronic diseases         | 104 (60.5)      | 336 (50.1)        | 1.52 (1.08–2.14) 0.016 |
| Drugs                            |                 |                  |                  |
| Antidepressants                  | 5 (2.9)         | 7 (1.0)           | 2.84 (0.89–9.05) 0.078 |
| Cardiovascular/Antihypertensive   | 39 (22.7)       | 82 (12.2)         | 2.10 (1.37–3.22) 0.001 |
| Opiates                          | 55 (32.0)       | 149 (22.4)        | 1.64 (1.14–2.38) 0.008 |
| Antiepileptics                   | 23 (13.4)       | 35 (5.2)          | 2.80 (1.61–4.88) 0.001 |
| Antipsychotics                   | 33 (19.2)       | 43 (6.4)          | 3.46 (2.12–5.65) 0.001 |
| Anxiolytics/Hypnotic             | 81 (47.1)       | 169 (25.2)        | 2.64 (1.87–3.73) 0.001 |
| Polypharmacy                     | 78 (45.3)       | 170 (25.4)        | 2.44 (1.69–3.49) 0.001 |

CI, confidence interval; IQR, interquartile range; OR, odds ratio.

*Missing 57 (6.7%).
did not fall. The H-L goodness-of-fit test was nonsignificant for model A with five risk factors (p-value = 0.6486) and model B with three risk factors (p-value = 0.9763). This indicates a useful goodness of fit for the two models and that they predict accurately on average and suitable for use in low- to high-risk patients. Additionally, model

Table 2  Gradient effect of age interval by quartiles and frequency of risk factors

| Age (years) | ≤51 | 52-68 | 69-80 | ≥81 | Total | p-Value trend |
|-------------|-----|-------|-------|-----|-------|--------------|
| Fall        |     |       |       |     |       |              |
| Yes (cases) | 13  | 37    | 56    | 66  | 172   | 0.0001       |
| No (controls) | 198 | 181   | 156   | 135 | 670   |              |
| Total       | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%) | 6.2 | 17.0  | 26.4  | 32.8| 20.4  |              |
| OR (95% CI) | 1.0 | 3.1 (1.6–6.0) | 5.5 (2.9–10.4) | 7.4 (4.0–14.0) |          |

| Sex         |     |       |       |     |       |              |
|-------------|-----|-------|-------|-----|-------|--------------|
| Male        | 101 | 130   | 95    | 88  | 414   | 0.0037       |
| Female      | 110 | 88    | 117   | 113 | 428   |              |
| Total       | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%) | 52.1 | 47.9  | 59.6  | 44.8| 43.8  |              |
| OR (95% CI) | 1.0 | 1.6 (1.1–2.4) | 0.9 (0.6–1.3) | 0.8 (0.6–1.3) |          |

| Balance     |     |       |       |     |       |              |
|-------------|-----|-------|-------|-----|-------|--------------|
| Poor        | 62  | 98    | 142   | 178 | 480   | 0.0001       |
| Good        | 149 | 120   | 70    | 23  | 362   |              |
| Total       | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%) | 29.4 | 45.0  | 67.0  | 88.6| 57.0  |              |
| OR (95% CI) | 1.0 | 2.0 (1.3–2.9) | 4.9 (3.2–7.4) | 18.6 (11.0–31.5) |      |

| Renal function |     |       |       |     |       |              |
|---------------|-----|-------|-------|-----|-------|--------------|
| Poor          | 29  | 35    | 68    | 104 | 236   | 0.0001       |
| Good          | 182 | 183   | 144   | 97  | 606   |              |
| Total         | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%) | 13.7 | 16.1  | 32.1  | 51.7| 28.0  |              |
| OR (95% CI)   | 1.0 | 1.2 (0.7–2.0) | 3.0 (1.8–4.8) | 6.7 (4.2–10.9) |      |

| Chronic diseases |     |       |       |     |       |              |
|-----------------|-----|-------|-------|-----|-------|--------------|
| ≥4              | 45  | 103   | 140   | 152 | 440   | 0.0001       |
| <4              | 166 | 115   | 72    | 49  | 402   |              |
| Total           | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%)   | 21.3 | 47.2  | 66.0  | 75.6| 52.3  |              |
| OR (95% CI)     | 1.0 | 3.3 (2.2–5.0) | 7.2 (4.6–11.1) | 11.4 (7.2–18.1) |      |

| Cardiovascular/Antihypertensive drugs |     |       |       |     |       |              |
|--------------------------------------|-----|-------|-------|-----|-------|--------------|
| Yes                                  | 7   | 22    | 44    | 48  | 121   | 0.0001       |
| No                                   | 204 | 196   | 168   | 153 | 721   |              |
| Total                                | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%)                        | 3.3 | 10.1  | 20.8  | 23.9| 14.4  |              |
| OR (95% CI)                          | 1.0 | 3.3 (1.4–7.8) | 7.6 (3.4–17.4) | 9.1 (4.0–20.8) |      |

| Anxiolytic/Hypnotic drugs |     |       |       |     |       |              |
|--------------------------|-----|-------|-------|-----|-------|--------------|
| Yes                      | 30  | 58    | 82    | 80  | 250   | 0.0001       |
| No                       | 181 | 160   | 130   | 121 | 592   |              |
| Total                    | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%)            | 14.2 | 26.6  | 38.7  | 39.8| 29.8  |              |
| OR (95% CI)              | 1.0 | 2.2 (1.3–3.6) | 3.8 (2.4–6.1) | 4.0 (2.5–6.4) |      |

| Antiepileptic drugs        |     |       |       |     |       |              |
|----------------------------|-----|-------|-------|-----|-------|--------------|
| Yes                       | 19  | 19    | 17    | 3   | 58    | 0.0241       |
| No                        | 192 | 199   | 195   | 198 | 784   |              |
| Total                     | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%)             | 9.0  | 8.7   | 8.0   | 1.5 | 6.9   |              |
| OR (95% CI)               | 1.0 | 1.0 (0.5–1.9) | 0.9 (0.4–1.7) | 0.2 (0.04–0.5) |      |
A demonstrated an excellent discriminatory capability (AUC = 0.8306) and model B demonstrated an acceptable discriminatory capability (AUC = 0.7164).

**Discussion**

Results from this study suggest that antiepileptic drugs, antipsychotic drugs, anxiolytic/hypnotic drugs and antidepressant drugs could be important risk factors for falls during hospital stay along with well-known risk factors such as age, sex and balance.

Among the risk factors for falls investigated in this study, the most clinically important identified risk factor was balance. The prevalence of poor balance and very poor balance was high (39.0 and 54.1%) among patients who experienced a fall during hospital stay. We know from earlier studies that intrinsic factors such as sensory input, muscle activation patterns, lower extremity function and gait speed are all factors known to decline due to old age and thus reduce balance and mobility (17,18). Acute illness in combination with sedentary behaviour among older patients during hospital stay reduces balance and mobility even further. A study investigating the characteristics and circumstances of falls in a hospital setting found lost balance to be the most common adverse event reported in connection to falls and ambulation to be the most common performed activity at the time of the fall (19). Results from our study indicate a high risk of falling on both clinically assessed levels of impaired balance, which may help identify patients most likely to benefit from preventive interventions. Personal assistance or a walking aid can in many cases prevent a fall, but these resources were not investigated in the current study. In clinical practice, we often see that the injury caused by a fall is often treated without assessing balance or investigating other possible causes of the fall (5). A reason for this could be that these investigations often consume a longer time than to treat the injury itself. Another reason could be lack of knowledge among the staff. Hence, based on our findings, we suggest a greater need for accurately assessing balance and mobility. This can help clinicians identify early signs of functional decline and assist with the individual’s interventions goal setting, and also with discharge planning. The latter is especially important considering that exercise improving strength and balance is known to prevent falls among community-dwelling older adults (20,21).

The drugs with the highest association to a fall were not unexpectedly the antidepressants drugs (OR = 3.85) and the antipsychotic drugs (OR = 3.27). This association is well known (22). However, we found that the frequency was very low for use of antidepressants (1.4%) and relatively low for the antipsychotics (9%). This could indicate that clinicians had been wisely cautious in prescribing these drugs in old age.

The prevalent use of medication was highest for anxiolytic/hypnotic drugs (29.8%). These drugs were given to 47% of the fallers and 25% of the nonfallers. Looking through the patients’ medical records, we found that the anxiolytic/hypnotic drugs are a widely prescribed

| Table 2 (Continued) | Age (years) | ≤51 | 52–68 | 69–80 | ≥81 | Total | p-Value trend |
|---------------------|------------|-----|-------|-------|-----|-------|--------------|
| Opioids             |            |     |       |       |     |       |              |
| Yes                 |            | 56  | 40    | 56    | 52  | 204   | 0.1383       |
| No                  |            | 155 | 178   | 156   | 149 | 638   |              |
| Total               |            | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%)       |            | 26.5| 18.3  | 26.4  | 25.9| 24.2  |              |
| OR (95% CI)         |            | 1.0 | 0.6 (0.4–1.0) | 1.0 (0.6–1.5) | 1.0 (0.6–1.5) |  |
| Antipsychotics      |            |     |       |       |     |       |              |
| Yes                 |            | 20  | 14    | 16    | 26  | 76    | 0.1115       |
| No                  |            | 191 | 204   | 196   | 175 | 766   |              |
| Total               |            | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%)       |            | 9.5 | 6.4   | 7.5   | 12.9| 9.0   |              |
| OR (95% CI)         |            | 1.0 | 0.7 (0.3–1.3) | 0.8 (0.4–1.5) | 1.4 (0.8–2.6) |  |
| Antidepressants     |            |     |       |       |     |       |              |
| Yes                 |            | 3   | 7     | 2     | 0   | 12    | 0.2168       |
| No                  |            | 208 | 211   | 210   | 201 | 830   |              |
| Total               |            | 211 | 218   | 212   | 201 | 842   |              |
| Frequency (%)       |            | 1.4 | 3.2   | 0.9   | 0.0 | 1.4   |              |
| OR (95% CI)         |            | 1.0 | 2.3 (0.6–9.0) | 0.7 (0.1–4.0) | –    |  |

CI; confidence interval; OR; odds ratio.
group of drugs before and during hospital stay, and often in unsuitable combination with other drug groups. This puts an important emphasis on the careful and precautionary administration of these drugs, especially in the presence of other risk factors such as old age and poor balance. Browne et al. (9) concluded that 80% of the fall risk medications suitable for intervention came from four drug classes: anti-emetics, opioid analgesics, anti-cholinergic agents acting on the bladder and benzodiazepines/hypnotics (9). Among six groups of central nervous system (CNS) active drugs investigated in the current study, four groups were identified as independent risk factors for falls. All four drug groups fall within these four classes. To prevent falls in the hospital setting, we suggest a more targeted fall risk medication review, with a particular focus on antidepressants, antiepileptics, antipsychotics and anxiolytic/hypnotic drugs.

From the time of hospital admission to discharge, we observed that the number of drugs administered during that period was higher and increased more during hospital stay, for the fallers as compared to the nonfallers. This is of a great concern knowing that the interaction of drugs themselves can lead to falls. Thus, we see the need for a more organised, targeted and systematic cooperation concerning medication prescribed during hospital stay and the discontinuation of medications upon discharge (23).

The association between old age and falls is long known, but in the clinical setting, age limit is still discussed when considering fall risk. In the literature, an increased fall risk is described among community-dwelling people 65 years or older, and Hitchco et al. found an average age of 63 among hospital fallers (5,19). In the present study, the median age of the patients was 69 years, and patients who fell were on average 12 years older than those with no fall. We further observed a gradient association between patient's age and fall, and that age was associated with the majority of risk factors considered. Therefore, we argue that age, in itself, is still a factor that always needs to be considered when aiming to prevent falls, and especially in relation to poor balance and mobility.

As for the other risk factors considered in our study, kidney function, chronic diseases and opioids, they were not significantly associated with falls, had minimal confounding effect and did not change the model’s predictive and discriminatory ability. Given the utility for clinical practice, we excluded these variables from the model presented, keeping those regarded most clinically relevant.

Strengths of the study include minor probability of selection bias as all patients registered with falls (cases), and a random sample of controls were selected from the same source population during the same time period. Limitations include the possibility of information bias because case status and risk factor status were assessed in retrospect from medical records. However, the resident physicians were masked to our research questions, and the potential misclassification would be nondifferential creating a bias towards the null effect (24). Due to the lack of information in the medical records, there is a possibility of unmeasured risk factors such as poor vision, dizziness and cognitive status of the patient. Elderly adults are particularly dependent on vision to maintain postural stability (25). Dizziness is a known reported cause to falls in the elderly and a well-known adverse effect of medications (1,26). Cognitive impairment contributes to falls in the hospital setting (1). On the other hand, and since poor vision, dizziness and cognitive impairment are all associated with impaired balance, and we argue that this has been taken into account by considering the balance factor (1,25,26). A further limitation in our study is the difficulty in establishing a correct temporal relationship between the risk factors and fall events. This is also the experience from one hospital, which raises the question of generalizability, but the

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Table 3 Risk factors differentiating patients with fall versus no fall using the multivariate logistic model

| Risk factors              | Level        | OR (95% CI)    | p-Value |
|---------------------------|--------------|----------------|---------|
| Model A                   |              |                |         |
| Male sex                  | Yes/no       | 1.82 (1.24–2.68) | 0.002 |
| Balance                   | Good         | (reference)    |         |
|                           | Poor         | 21.50 (10.26–45.04) | 0.001 |
|                           | Very poor    | 19.62 (9.55–40.27) | 0.001 |
| Anxiolytics/Hypnotic drugs| Yes/no       | 1.80 (1.22–2.67) | 0.003 |
| Antiepileptic drugs       | Yes/no       | 1.13 (1.11–4.06) | 0.022 |
| Antipsychotic drugs       | Yes/no       | 2.01 (1.15–3.51) | 0.014 |
| Model B                   |              |                |         |
| Age                       | 10 year increase | 1.51 (1.34–1.69) | 0.001 |
| Antipsychotic drugs       | Yes/no       | 3.27 (1.94–5.51) | 0.001 |
| Antidepressants           | Yes/no       | 3.85 (1.09–13.63) | 0.037 |

CI, confidence interval; OR, odds ratio.
Two-model presentation was used to avoid the problem of collinearity between the risk factors of fall.
sample of patients, both cases and controls, was taken from three different wards.

**Clinical implications**

Clinicians should work to improve patient’s safety and reduce the risk of falls by accurately assessing balance and mobility among older patients as a form of primary prevention. We recommend that a review of the patient medications should be conducted upon falling, as a form of a secondary preventive strategy against falls. While at the same time prompting a more robust and pragmatic primary preventive strategy against falls, even before the fall happening, including a more dynamic approach to the patient medications upon hospital admission, under hospital stay, and upon discharge, especially in the presence of one or more of the important risk factors for falls.

More clinical studies, preferably prospective studies, are needed to be done with regard to the clinicians approach to the patients’ medications before and after falls as a form of primary and secondary prevention strategy accordingly.

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**Conflict of interest**

The authors report no conflicts of interest in this work. In the preparations of this manuscript, all tips for publishing ethics are followed.

**Author contribution**

The authors worked together to perform the case–control study. The first author was mainly responsible for preparing the manuscript. The second author was vital in the gathering of the clinical and medical data, and had an expertise in the field of medical care for the elderly. The third author was responsible for the accuracy of the analysis and interpretation of the results. The authors report no conflicts of interest in this work. The three authors G. Cathrine L. de Groot, Ahmad Al-Fattal and Irene Sandven meet the Scandinavian Journal of Caring Sciences criteria for contribution to authorship.

**Ethical approval**

This study was registered at the Norwegian Social Science Data Services (NSD) on 3 June 2015, with the registration number 43162. Enrolment of patients started in February 2016. No ethical approval typical for empirical studies was needed.
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