

Medication use and falls in community-dwelling older persons*

KAVEN D. KELLY[1], WILL PICKETT[2], N. YIANNAKOULIAS[3], BRIAN H. ROWE[4], DON P. SCHOPFLOCHER[5], LARRY SVENSON[5], DON C. VOAKLANDER

University of Alberta, Edmonton, Alberta, Canada
[1]Community Health, University of Northern British Columbia, 3333 University Way, Prince George, BC, Canada, V2N 4Z9
[2]Epidemiology, Arch St. Queens University, Kingston, Ontario, Canada, K7L 3N6
[3]Division of Emergency Medicine and [4]Public Health Sciences, University of Alberta, Edmonton, Alberta, Canada
[5]Alberta Health and Wellness, Health Surveillance, Edmonton, Alberta, Canada

Address correspondence to: K. D. Kelly. Fax: (+250) 960 5744. Email: kellyk@unbc.ca

Abstract

Background: the association between injurious falls requiring a visit to the emergency department and various classes of medications was examined in a case-control study of community living persons aged 66 years and older.
Methods: administrative databases from an urban health region provided the information used. Five controls for each case were randomly selected from community dwelling older persons who had not reported an injurious fall to one of the six regional emergency departments in the study year. Two series of analyses on medication use within 30 days of the fall were conducted using logistic regression, the first controlling for age, sex, and median income, the second controlling for co-morbid diagnoses as well.
Results: during the study year there were 2,405 falls reported by 2,278 individuals to six regional emergency departments giving a crude fall rate of 31.6 per 1,000 population per year. The initial analysis identified seven medication classes that were associated with an increased risk of an injurious fall, while controlling for age, gender and income. However, with further analyses controlling for the additional effects of co-morbid disease, narcotic pain-killers (odds ratio 1.68), anti-convulsants (odds ratio 1.51) and anti-depressants (odds ratio 1.46) were significant independent predictors of sustaining an injurious fall.
Conclusion: these results are based on a Canadian population-based study with a large community sample. The study found that taking certain medications were independent predictors of sustaining an injurious fall in our elderly population – in addition to the risk associated with their medical condition.

Keywords: *aged, accidental falls, risk factors, drug therapy*

Introduction

Injuries sustained due to falls are an important health problem for older persons residing in the community [1] and the problem will become even more significant as our population ages and the older population remain longer in their homes. Approximately one third of persons aged 65 years and older and living at home have one or more falls per year [2, 3]. The consequences of falling, for this population, are variable. Approximately 10–25% of falls result in serious injury [2], primarily fractures, but other well-recognised consequences of falls include other fractures, soft tissue injury, dehydration and pneumonia [4]. Forty per cent of hospital admissions among persons over the age of 65 are reported to be fall-related injuries and result in an average length of stay of 12 days [5]. Falls that do not lead to injury often begin a cascade of decreased mobility, decreased activities of daily living, decreased functioning and increased susceptibility to disease [6].

Falls in the elderly possess a multi-factorial aetiology that involves an interaction between intrinsic (those related to the individual) and extrinsic factors (those associated with environmental features) [3, 7]. Intrinsic factors include decreased functional skills, lower-extremity weakness, neurological conditions, diminished cognitive function, reduced vision and hearing, low blood pressure, acute illness, and medication use [2, 4, 5, 7–12]. Identification of persons at high risk and those who have begun to experience falls is important, so that these individuals can

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be systematically evaluated for an underlying disease, medication effects, and environmental risk factors [12].

The role of medications, as a contributing factor of falling among older persons, has recently received much attention – primarily because medication exposure may be an important modifiable risk factor in fall prevention. Mechanisms suspected of contributing to the risk of falling include reduced metabolic capacity and renal activity as a result of the ageing process – therefore extending medication half-life, psychomotor impairment resulting from some psychotropic medications, medications that lead to orthostatic hypotension and those that induce ambulation (associated with the use of diuretics) [7]. Although the relationship between medication use and the risk of falling in older persons residing in institutional settings has been examined [2, 7], these relationships among older persons living in the community have yet to be firmly established [7, 9, 10, 13, 14]. Further research is needed to distinguish drug effects from those of underlying psychopathology, particularly for the most commonly used drugs outside of the institutional setting [14].

The purpose of this study was (i) to examine the association between medication use in community living persons aged 66 years or older and the risk of injurious falls requiring presentation to the emergency department and (ii) to estimate the above magnitude while controlling for the simultaneously confounding effects of underlying medical conditions.

Methods

The sampling frame was the population from the Capital Health Region located in the greater Edmonton area of the province of Alberta in Canada. The Capital Health Region is an administrative health zone with a population of approximately 800,000. Data for this study were obtained exclusively from five computerised administrative data sets that were linked deterministically using a unique personal health number. These data sets included: comprehensive emergency patient episodes recorded in the Alberta Ambulatory Care Classification System; the Alberta Long-Term Care Registry which maintains a register of all persons residing in long-term supported care; the Physicians Claim File which lists ICD-9 diagnostic codes for all patient encounters, the Blue Cross Drug Insurance Plan which maintains billing data for all medication purchases for all seniors aged 65 and older who are automatically eligible for coverage in Alberta, and the Alberta Health Insurance Plan Registration File which lists all current persons eligible for government health insurance (>95% of the population). All datasets are maintained to province-wide standards within a uniform health system where the government is the single provider of acute health care.

The case-control selection was made in the following fashion. Cases were all persons 66 years and older presenting to any of the six emergency departments within the Capital Health Region with an injurious fall in the 1997/1998 fiscal year. An injurious fall was identified using ICD-9 External Cause of Injury Codes (E880.0-E886.9 and E888) [15]. Five controls (also aged 66 years or older) were randomly selected from the community (Alberta Health Registration file), and were temporally matched with a case on health/medication utilisation. Specifically, cases were matched to controls that utilised the health system within the same time period as the cases' fall date – therefore data on co-morbidities, hospitalisation and medication use were retrieved within the same time period. Non-community dwelling older persons (those living in long-term or aged care facilities) were excluded from the selection of cases and controls using the Long Term Care file to establish residency.

Demographic and socio-economic information (with the exception of median income) was obtained from Alberta Health Insurance Plan Registration file and medical co-morbidity was established from the Physicians Claims File. Median income was obtained from the 1996 Canadian Census – median income of the census tract of residence was used as a proxy for individual income. Medication use was determined by proxy from prescription billings available from the Blue Cross Drug Insurance Plan – available to all persons aged 65 years and older.

With the dependent variable being an injurious fall requiring presentation to the emergency department (cases), the independent variable of interest was medication use 30 days prior to the incident and covariates included age, gender, median income, hospitalisation within the previous year and co-morbidities within the past year. The major classes of medications included in the study were: anti-histamines, narcotic pain killers, anti-inflammatories, anti-convulsants, anti-depressants, anti-psychotics, sedatives, anti-parkinsonian agents, electrolytics, visual impairment agents, anti-ulcer agents, corticosteroids, sex hormones, diabetes agents, thyroid agents, anti-coagulants, and anti-hypertensive agents. These are broad classification categories used by Alberta Health. Due to the potential of cell sizes on medication use being less than five, detailed information was not obtained. Medications listed in each category can be obtained from the authors. The co-morbidities included in the analyses were (see Appendix for ICD9 codes used): eye disorders, incontinence, nutritional deficiencies, Parkinson's disease, osteoarthritis, dementia, depression/psychosis, neurosis, osteoporosis, cerebrovascular disease, hypertension, cardiovascular disease, diabetes, cancer, gait/balance disorders, seizures and injury trauma.

Univariate comparisons were made using Student's *t*-test for continuous variables and chi-square tests for categorical variables. Multivariable comparisons were made using logistic regression. SPSS 9.0 for windows was used for all statistical analyses.

Table 1. Un-adjusted and adjusted odds-ratios relating medication classes to injurious falls

	Cases (n = 2,278)	Controls (n = 9,112)	Un-adjusted OR (95% CI)	Adjusted** OR (95% CI)	Adjusted*** OR (95% CI)
Demographics					
Gender (Female)	69%	57%*	1.65 (1.49, 1.81)	1.41 (1.27, 1.56)	1.42 (1.28, 1.58)
Age; mean (SD)	78.5 (7.7)	74.5 (6.7)*	1.08 (1.07, 1.09)	1.07 (1.07, 1.07)	1.07 (1.06, 1.08)
Income; mean (SD)	$19,456 ($4,527)	$19,798 ($4,517)*	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)
Any hospitalisation in prior year	22%	12%*	2.11 (1.87, 2.38)		1.42(1.23,1.63)
Co-morbidities					
Eye disorders	39%	33%*	1.29 (1.18, 1.42)		1.10 (0.99, 1.22)
Incontinence or urinary tract disorders	5%	4%*	1.34 (1.07, 1.67)		1.10 (0.87, 1.39)
Nutritional deficiencies	0.1%	0.2%	0.38 (0.09, 1.63)		0.34 (0.08, 1.49)
Parkinson's disease	2%	1%*	2.65 (1.78, 3.96)		2.05 (1.32, 3.19)
Osteoarthritis	21%	17%*	1.33 (1.18, 1.49)		
Dementia	6%	1%*	4.52 (3.55, 5.77)		2.32 (1.78, 3.02)
Depression/ psychosis	13%	6%*	2.37 (1.93, 2.59)		1.36 (1.14, 1.61)
Neurosis	20%	13%*	1.63 (1.44, 1.83)		1.27 (1.11, 1.45)
Osteoporosis	7%	4%*	1.56 (1.28, 1.89)		1.39 (1.13, 1.70)
Cerebrovascular disease	6%	3%*	2.38 (1.92, 2.94)		1.50 (1.18, 1.89)
Hypertension	31%	31%	0.99 (0.89, 1.09)		0.91 (0.82, 1.02)
Cardiovascular disease	25%	19%*	1.43 (1.28, 1.60)		1.08 (0.95, 1.23)
Diabetes	9%	8%	1.09 (0.92, 1.28)		1.18 (0.96, 1.46)
Cancer	14%	12%	1.22 (0.98, 1.28)		1.00 (0.87, 1.16)
Gait/balance disorder	4%	4%	1.24 (0.99, 1.57)		0.90 (0.70, 1.16)
Seizures	1%	0.4%*	2.92 (1.81, 4.73)		2.22 (1.30, 3.79)
Other injury trauma	32%	21%*	1.78 (1.61, 1.98)		1.57 (1.14, 1.75)
Medication Classes					
Anti-histamines	0	0.1%	0.61 (0.00, 9.89)	0.02 (0.00, 73.56)	0.02 (0.00, 65.85)
Narcotic pain killers	9%	4%*	2.11 (1.78, 2.53)	1.74 (1.44, 2.01)	1.68 (1.39, 2.03)
Anti-inflammatories	7%	6%	1.18 (0.98, 1.42)	1.02 (0.85, 1.24)	1.02 (0.84, 1.24)
Anti-convulsants	4%	2%*	2.52 (1.92, 3.32)	1.94 (1.45, 2.61)	1.51 (1.11, 2.06)
Anti-depressants	10%	5%*	2.35 (1.99, 2.79)	1.68 (1.40, 2.04)	1.46 (1.21, 1.78)
Anti-psychotics	2%	1%*	2.86 (1.98, 4.12)	1.74 (1.18, 2.57)	1.35 (0.90, 2.02)
Sedatives	12%	7%*	1.86 (1.61, 2.16)	1.32 (1.12, 1.55)	1.15 (0.97, 1.36)
Anti-parkinsonian agents	1%	0.5%*	2.57 (1.59, 4.13)	1.95 (1.17, 3.24)	1.54 (0.87, 2.75)
Electrolytics, water balance agents	13%	8%*	1.70 (1.47, 1.97)	1.09 (0.93, 1.29)	1.10 (0.93, 1.31)
Visual impairment agents	2%	1.5%	1.41 (1.02, 1.95)	1.11 (0.79, 1.56)	1.17 (0.82, 1.65)
Anti-ulcer agents	10%	7%*	1.45 (1.24, 1.70)	0.99 (0.83, 1.18)	0.93 (0.78, 1.12)
Corticosteroids	4%	3%	1.32 (1.03, 1.70)	1.07 (0.82, 1.40)	1.00 (0.76, 1.31)
Sex hormones	2%	3%	0.78 (0.57, 1.06)	0.77 (0.56, 1.06)	0.75 (0.54, 1.04)
Diabetes agents	5%	4%	1.09 (0.87, 1.36)	1.03 (0.81, 1.30)	0.87 (0.65, 1.16)
Thyroid agents	6%	4%*	1.65 (1.35, 2.02)	1.16 (0.93, 1.44)	1.13 (0.91, 1.41)
Anti-coagulants (does not include aspirin or antiplatelet agents)	3%	2%*	2.02 (1.53, 2.67)	1.57 (1.17, 2.10)	1.33 (0.97, 1.80)
Anti-hypertensive agents	16%	12%*	1.36 (1.19, 1.55)	1.00 (0.86, 1.16)	0.98(0.84, 1.15)

*$P < 0.05$.

**Adjusted for age, gender, income and all medication classes.

***Adjusted for age, gender, income, previous hospitalisations, all co-morbid conditions, and all medication classes.

Results

During 1998, there were 2,404 falls reported by 2,278 individuals aged 66 years and older that presented to the emergency department for medical care in the six health regions. The crude injurious fall rate was 31.6 per 1,000 population per year (95% C.I.: 30.3, 32.9) with 21.6% of fallers being admitted to hospital. The predominant diagnosis was fractures (54.5%), followed by contusions (13.6%) and lacerations (12.8%). Most injuries occurred to the upper extremity (31.2%), followed by the lower extremity (31.1%) and the head (17.8%). Further etiological analyses were limited to the first fall.

Columns 2 and 3 of Table 1 outline the demographic, economic and health-related variables in the case and control groups. When compared with the control group, cases were older, more likely to be female, had a lower annual income. Cases were also more likely to be hospitalised in the previous year than the controls. Overall, cases had been diagnosed with more co-morbid diseases than the control group. In the vast majority of co-morbid diseases, the differences were statistically significant, with the exceptions of nutritional deficiencies, hypertension, diabetes, cancer and gait/balance disorders (similar prevalence for both groups). As observed in Table 1, cases were prescribed medications from the specific medication classes significantly more often than controls. The exceptions here are that anti-inflammatory, visual impairment, corticosteroid, sex hormone and diabetic agents, were prescribed similarly between the two groups.

Column 5 of Table 1 illustrates the association between medication use and fall injury, after controlling for the effects of age, gender, and income. All medications listed in Column 4 of Table 1 were included in the analysis. As indicated, along with increasing age and being female, narcotic, anti-convulsant, anti-depressant, anti-psychotic, sedative, anti-parkinsonian and anti-coagulant agents were significant predictors of an injurious fall. However, when co-morbid diagnoses are controlled for as well, age and gender continued to be significant predictors, but the number of medication classes reduced substantially (Column 6 of Table 1). Being hospitalised within the previous year, taking narcotic, anti-convulsant and anti-depressant medications were significant predictors of an injurious fall. The magnitude of increased risk associated with these medication classes range from relative odds of 1.46 (anti-depressants), 1.51 (anti-convulsants) to 1.68 (narcotic pain killers). The co-morbid conditions that increase the risk of falling include Parkinson's disease, dementia, depression/psychosis, neurosis, osteoporosis, cerebrovascular disease, seizures and a previous history of injury trauma.

Discussion

The major finding of this study was that taking medications from seven specific medication classes were independent risk factors for predicting an injurious fall in this elderly population. (Increasing age and being female were also significantly associated with sustaining an injurious fall, yet income was not.) The significant medication classes included; narcotics, anti-convulsants, anti-depressants, anti-psychotics, sedatives, anti-coagulants and anti-parkinsonian agents. However, when existing co-morbid conditions and being hospitalised within the previous year were also controlled for, age and gender continued to be significant predictors of falling, but only narcotic, anti-convulsants and anti-depressants were significant medication predictors. This means that, regardless of their age, gender, income, previous hospitalisation and medical condition, patients taking narcotic, anti-convulsant and anti-depressant medications were significantly more likely to suffer from an injurious fall. We found that a person taking narcotic pain agents had a 68% greater chance of suffering from an injurious fall than persons not taking narcotic agents, while controlling for age, gender, income, co-morbidities and recent hospitalisation. Similarly, persons taking anti-convulsant or anti-depressant agents were approximately 50% more likely (51% and 46% respectively) to sustain a serious fall compared to persons not taking these medications, again while controlling for the above mentioned variables. Further, if medications in multiple categories are used, the likelihood of falling increases. For example if an individual were taking narcotic pain agents, anti-convulsants, and anti-depressants, they would have 3.3 times the risk of suffering an injurious fall. Fortunately, only 0.1% of this population take all three.

Associations between advancing age, being female and having an increased risk of falling in older adults has been reported previously [3, 8, 16]. In the current study of persons >65 years of age, women had a 40% greater chance of falling compared to men and the fall risk increased slightly with each year of age. Similarly, the associations between recent hospitalisation [4, 16], specific co-existing medical conditions [6, 8, 12] and the increased falling risk have also been previously established. Furthermore, the specific associations between certain medication classes and falling risk in an institutional setting has been addressed [4, 7, 9–11], and to some extent in a community setting [9, 10, 12, 17, 18] – however, only a limited number of medication classes were examined in these studies.

Nevertheless, the magnitude of medication effects that are commonly prescribed to older adults living in the community, while controlling for their underlying medical conditions, has never been studied. This is an important distinction that needs to be made, because it has been thought that the relationship between medication use and increased risk of falling in older adults was attributable to the underlying condition for which the medications were prescribed [9]. In this study, we found that older adults taking narcotics, anti-convulsants, and anti-depressants, were at an increased risk of falling, while

controlling for their medical conditions. Elderly persons living in the community, taking narcotic, anti-convulsant or anti-depressant agents are at an increased risk of sustaining an injurious fall that requires emergency department treatment – in addition to any risk associated with their medical condition. Since taking these medications is often a necessity for some individuals, their discontinuation because of an association with falling is not a viable option.

However, a few patient management modifications may be possible. For example, older persons taking the above medications should have their medications reviewed on a regular basis by their primary physician, in order to reduce the number of required medications. Perhaps medications with shorter elimination half-life can be used as alternatives – this is specifically in reference to sedatives and narcotics. Conversely, re-scheduling of medication intake may be possible to reduce their cumulative effects at certain hours of the day. A recent meta-analysis also suggests that withdrawal of psychotropic medications would likely reduce the incidence of falls in elderly people [19] and this might be a conceivable option for some individuals. Ultimately, the results of this study emphasise the importance of close monitoring of medication prescription use with the elderly population residing in the community, to reduce the individual overall burden of risk and the significance of implementing fall prevention strategies for elderly persons taking these medications.

The limitations of this study warrant recognition. First, only falls related to emergency and hospital treatment are presented. Falls treated in clinics, self-treated or that did not result in an injury are not included. We also used a proxy indicator for medication use – medications purchased within the past 30 days, not medication administration. It is possible, that in a few instances, medications were purchased and not subsequently taken. However, the use of this proxy measure merely dilutes the effect of the predictor medications. Likewise, income measure was inferred from the residential census tract, and is therefore a crude estimate of individual socioeconomic status. It is possible that a more accurate measure of personal income may have contributed differently to the model. We also did not have a measure of non-prescription medication use, alcohol or illicit drug use. Information on these variables is not available in any of the six databases, therefore only the effects of prescription medication use on injurious falls were measured. Additionally, there exists a potential under-reporting of medical conditions (co-morbidities) since we obtained this information from administrative data. Absence of a coded disease does not necessarily mean an absence of the condition. Case ascertainment through the emergency department may also be a source of error as individuals could have been advised to treat all injury seriously based on their co-morbidity or medication profiles. For example those taking anti-coagulants may be more likely to visit the emergency department due to fear of uncontrolled bleeding. This would artificially elevate the estimated odds ratio for this medication class. There is also the possibility that error occurred in the measurement of co-morbid conditions. The measurement of these conditions relies on accurate and consistent coding by medical professionals. If there is inconsistency in coding or diagnostic transfer occurs between similar conditions, some non-random error may have been introduced. Another issue that arises with this type of research is that multiple medication classes may be used to treat multiple co-morbid classifications (e.g. mental health or heart problems). This makes it tremendously difficult to sort out the combined or singular effects of any specific medication and co-morbidity pairing. And finally, other known risk factors of injurious falls in the elderly, such as measures of body weight, balance, physical fitness, lower extremity muscle strength and assisted activities of daily living [20, 21] were not included in our analyses (these variables were not present in the administrative datasets). Therefore further research is encouraged to determine the effect modification of physical functioning and medication use on injurious falls.

Nonetheless, there are several methodological strengths of this study. We used a large community-based sample in which the control group was representative of the total population – therefore increasing the external validity of the study. The possibility of a selection bias was minimised as all cases were included in the study and controls were randomly selected from the population-based administrative dataset. Since health care coverage in Canada is universal, with every person over the age of 65 having premium-free health insurance coverage, the dataset includes the entire population of interest, therefore reducing the potential effects of selection bias to a minimal. Cases and controls were temporally matched to eliminate season variability and identical measurements for all variables in both the case and control groups were obtained. Furthermore, the measure of co-morbidity was current, such that if the co-morbidity diagnosis was indicated on the physicians claim file within the 12 months prior to the fall date. All data were collected in a uniform health system, therefore measurement bias was minimised and direct linkage of data using unique identifiers was conducted to control mis-linked record error. Finally, the six emergency departments used were the only ones serving the study area, thus complete case coverage was achieved.

Conclusion

The results are based on a Canadian population-based study with a large community-based sample. Cases and controls were matched on time of health care utilisation. The study estimated the magnitude of association between medication use and risk of injurious falls in the community-dwelling older population, while controlling for the effects of co-morbidity, age, gender and income.

The effects of 17 specific classes of medications were assessed and several different co-morbid conditions were included in the analyses. The major findings were that taking medications from seven specific medication classes (narcotic, anti-convulsant, anti-depressant, anti-psychotic, sedative, anti-parkinsonian and anti-coagulant agents) were independent risk factors for predicting an injurious fall in our elderly population – after controlling for the effects of age, gender, and income. However, when existing co-morbid conditions and being hospitalised within the previous year were also controlled for, only narcotic, anti-convulsants and anti-depressants were significant medication predictors of an injurious fall. These findings support the hypothesis that some medication types are independent risk factors for injurious falls in the elderly residing in the community – in addition to the risk associated with their medical condition.

Key points

- Results are based on a Canadian population-based study with a large community sample.
- Cases and controls were matched on time of health care utilsation.
- Estimates of the magnitude of association between medication use and risk of injurious falls in the community dwelling older population, while controlling for the effects of co-morbidity, age, gender and income were generated.
- The use of narcotic, anti-convulsant and anti-depressant agents, significantly predicted an injurious fall in our elderly population – in addition to the risk associated with their medical condition.
- These findings support the hypothesis that some medication types are independent risk factors for injurious falls in elderly residing in the community.

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Appendix

Co-morbid condition	International Classification of Disease – Version 9 – code ranges used
Disorders of the eye	360–379
Incontinence or urinary tract problems	788
Nutritional deficiencies	260–269
Parkinson's disease	332
Osteoarthritis	715–716
Dementia/cognitive impairment	390, 331
Depression/psychosis	295–299, 311
Neurotic disorder	300–309
Osteoporosis	733
Cerebrovascular disease	430–438
Hypertension	401–405
Cardiovascular disease	410–414, 420–429
Diabetes	250
Cancer	140–239
Gait or balance disorders	333–334, 342, 359, 365–366,369, 458, 721
Previous injury	800–959