Impact of Drug Use and Comorbidities on In-Hospital Falls in Patients with Chronic Kidney Disease

Mallik V Angalakuditi, Joseph Gomes, and Kim C Coley

In-hospital falls are a major problem in healthcare institutions and contribute to morbidity and mortality in this setting. Falls are the third leading cause of deaths due to unintentional injury in the US. Most studies evaluating risk factors for patient falls focus on elderly patients since falls in this population are a significant cause of morbidity and the largest single cause of death due to injury.[1] From 1988 to 2000, the rate of death due to unintentional falls increased in the elderly from 24.3 to 32.7 in men and 18.8 to 27.3 in women per 100,000 people.[2] In 2003, there were more than 1.8 million patients older than 65 years of age who were treated in emergency departments for fall-related injuries, and more than 421,000 of these individuals were hospitalized.[3] Nearly 13,000 elderly people died from fall-related injuries in 2002 and more than 60% of them were older than 75 years of age.[4]

In contrast, very little is known about the risks and impact of in-hospital falls in the broader adult population, despite the fact that falls are problematic in this population, as well. In a study evaluating fall risk in hospitalized patients, approximately 42% of the patients were younger than 65 years of age.[5] This study also reported that patients with chronic kidney disease (CKD) were among those at highest risk for experiencing an in-hospital fall, irrespective of advanced age. According to a study by Lindberg and Moe,[6] patients with kidney disease have a higher incidence of fractures compared with controls. Falls in hospitalized patients not only increase the length of

BACKGROUND: In-hospital falls are a major problem in healthcare institutions and contribute to morbidity and mortality in this setting. Patients with chronic kidney disease (CKD) were previously found to be at higher risk for experiencing an in-hospital fall.

OBJECTIVE: To evaluate the association between comorbidities and drug use with the risk of in-hospital falls in adults with CKD.

METHODS: A retrospective case–control study was conducted in patients with CKD hospitalized between January 1, 1998, and June 30, 2003. Cases included patients who experienced an in-hospital fall, were 18 years of age or older, and had been hospitalized for more than 24 hours. For every case, 2 controls were identified and matched for CKD, age, and sex. Information about comorbidities and drug use was collected from an electronic medical data repository. Statistical tests performed were t-tests, χ^2 analysis, and multivariate logistic regression, using occurrence of a fall as the dependent variable and race, comorbidities, and drug groups as covariates.

RESULTS: There were 635 fall cases that met study criteria. The mean age of patients was 68 ± 15 years, 54% were female, and 82% were white. There were 1270 matched controls with CKD who were included in the regression analysis. Comorbidities that increased the likelihood of experiencing an in-hospital fall were dementia (OR 2.63), pneumonia (OR 1.72), gastrointestinal disease (OR 1.41), and diabetes (OR 1.31). Drugs associated with an in-hospital fall were antidepressants (OR 1.65) and anticonvulsants (OR 1.52).

CONCLUSIONS: Several comorbidities, especially dementia, significantly increase the risk of experiencing an in-hospital fall in patients with CKD. Drugs that place CKD patients at risk include antidepressants and anticonvulsants.

KEY WORDS: in-hospital falls, kidney disease.

stay, severity of the existing illness, and cost of hospitalization, but also adversely affect quality of life, including emotional, functional, and social well-being.[7,8]

Reducing falls was identified by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) as an important National Patient Safety Goal for the years 2006–2007.[9] To maintain their accreditation, hospitals are expected to develop and implement a fall reduction program and be able to assess patient risk for having a fall. Previous work suggests that guidelines developed to be in compliance with the JCAHO patient safety goal should in-

Author information provided at the end of the text.

clude risk reduction for patients with CKD.[5] Strategies for preventing falls in this population might be easier to implement if additional risk factors were identified to further target the at-risk population. Using these factors, targeted patients could receive additional attention and supervision to prevent a fall. Therefore, we aimed to evaluate the association between comorbidities and drug use with the risk of in-hospital falls in adults with CKD.

Methods

A retrospective case–control study of patients with an in-hospital fall occurring between January 1, 1998, and June 30, 2003 was conducted at a university medical center. All patients 18 years of age or older who experienced an in-hospital fall (ie, cases) were identified from the hospital's risk management database (RMD). Every fall reported that occurs in the hospital, regardless of the outcomes, is documented in the RMD by a nurse or other healthcare provider. All patients identified in the RMD were then linked to their corresponding inpatient visit data housed in the hospital's electronic medical record data repository. Only identified patients who could be linked to their corresponding inpatient visit data were eligible for the study. For patients with multiple falls during the same hospital admission or multiple admissions with an in-hospital fall, only the first fall was included in this study. To be included as a case, patients had to be hospitalized for more than 24 hours and have CKD defined as a glomerular filtration rate (GFR) less than 60 mL/min on admission. GFR was calculated using the 4-variable Modification of Diet in Renal Disease formula.[10] For every case, 2 matched controls were identified (1:2 ratio). Control patients were matched on age, sex, and GFR less than 60 mL/min on admission.

DATA COLLECTED

For fall cases, the date, time, and location of the fall were collected from the RMD. The outcome of the fall, if recorded in the RMD, was also recorded. Patient and clinical data were obtained from the hospital's electronic medical record data repository, which houses clinical and financial information for the health system. Diseases and procedures are coded at discharge in each patient's medical record using International Classification of Diseases Ninth Clinical Modification (ICD-9-CM) codes. A maximum of 25 ICD-9 diagnosis codes and 25 procedure codes are available for each patient admission. Drugs and biologics dispensed through the pharmacy are coded individually. Data collected for both cases and controls included admission and discharge dates, age, sex, hospital service, discharge status, prescribed drugs, and comorbidities. The discharge status describes the circumstance of the patient at the time of dis-

charge (eg, discharged to home, transferred to skilled nursing facility, died) and does not reflect the outcome of the fall. Previously published literature regarding drug use and hospital fall risk was used to select which drug classes to include in this study.[11-13] Drugs identified included antipsychotics, benzodiazepines, anticonvulsants, antiarrhythmics, antihistamines, and antidepressants. Only drugs administered within 2 days of the fall date in the cases and reference fall date in the control group were extracted.

A reference fall date was calculated for each control patient by using the same timeframe (eg, days to fall after hospital admission) as its matched fall case. This method was employed so as to not overestimate drug use in the control group compared with the cases. The drugs prescribed on the day of the fall were not included because it was not possible to determine whether they were administered prior to the fall.

DATA ANALYSIS

Characteristics of case and control groups were compared using paired t-tests for normally distributed parameters, Mann–Whitney U test for nonparametric data, and χ^2 analysis for categorical data. A logistic regression model was developed with occurrence of a fall as the dependent variable. Each independent variable was first entered into a univariate regression model to determine its significance on fall risk. Independent variables assessed included comorbidities, drug groups (described above), and race. Collinearity between comorbidities and drug group (eg, cardiac arrhythmias and antiarrhythmics) was assessed using the Goodman and Kruskal tau test. Variables found significant at a p value less than 0.1 were subsequently entered into the multivariate model using the backward conditional approach to determine the best fitting model. Adjusted odds ratios and 95% confidence intervals were determined. A power analysis was conducted for a multivariate logistic regression by setting power to 0.80, type I error rate to 0.05, and a multiple correlation of 0.5 among predictors. A sample of at least 570 patients was determined to provide enough power to detect an odds ratio of 1.5 as significant. All analyses were conducted using SPSS Version 11.5 (SPSS Inc., Chicago, IL). All data were de-identified according to Health Insurance Portability and Accountability Act guidelines prior to their transfer to the investigators. This study was reviewed and designated as exempt from patient informed consent by the university's institutional review board.

Results

CASES

There were 635 fall cases that met inclusion criteria. The mean and median ages of patients with CKD experiencing an in-hospital fall were 68.5 ± 15.3 years and 71

years, respectively. There were 34 (5.4%) patients between 18 and 40 years of age, 196 (30.9%) between 40 and 65 years of age, and 405 (63.8%) older than 65 years of age. A large proportion of this study population was elderly, which is representative of the general CKD patient population. There were 341 (53.7%) females and 294 (46.3%) males. The majority of the population was white (519; 81.7%). The mean length of stay for the entire hospital admission was 20.5 ± 31.9 days. Most (219; 34.5%) fall cases were in the general medicine service, followed by surgical (115; 18.1%), cardiology (102; 16.0%), and rehabilitation (52; 8.2%) services.

Fall Information and Discharge Status

Table 1 describes the time of the fall in relation to total length of stay for fall cases. The majority (57.6%) of patients fell within the first week of hospitalization and most (66.3%) were discharged within a week after their falls. The most common (252; 39.6%) fall location was from the bed. Twenty-three percent of patients fell while ambulating, 102 (16.0%) fell in the bathroom, 58 (9.1%) from the chair, 58 (9.1%) were found on the floor (ie, the location from which the patient fell was not witnessed), and 19 (3%) fell in other locations. The immediate outcome of the fall in 491 (77.3%) cases was not recorded in the RMD. In the 144 patients for whom outcome data were available, abrasion was reported in 34 (5.4% of total population) patients, pain in 18 (2.8%), laceration in 14 (2.2%), blood loss in 12 (1.9%), and fracture in 8 (1.3%). Most (243; 38%) patients were discharged to home or home health care. Other discharge sites included nursing homes (176; 27.7%), rehabilitation units (117; 18.4%), and short or intermediate skilled-care nursing facilities (37; 5.8%). Thirteen (2.0%) patients were transferred to other hospitals. Forty-nine (7.7%) patients died while hospitalized; however, it was not possible to determine whether the fall contributed to mortality.

CASES AND CONTROLS

Length of Stay and Comorbidities

All patients with CKD who fell were matched on age, using 5 year groupings; sex; and GFR less than 60

mL/min. The mean and median ages of control patients were 69.1 ± 15.3 years and 72 years, with no significant difference between the case and control groups. In the control group, there were 62 (4.9%) patients between 18 and 40 years of age, 380 (29.9%) between 40 and 65 years of age, and 828 (65.2%) who were older than 65 years of age. When these results were compared with those of the cases, no statistically significant differences were found. Cases had a significantly longer median length of stay compared with the control group (13 vs 7 days; p < 0.001). Multiple comorbidities were common in the cases (p < 0.001), with at least one comorbidity recorded in 83.1% and at least 2 comorbidities in 54.0% of this group. In contrast, 76.3% and 43.4% of controls had at least 1 or 2 comorbidities, respectively. Table 2 summarizes the frequency of specific comorbidities in the case and control groups. Compared with control patients, fall case patients were more likely to have congestive heart failure, diabetes, dementia, and pneumonia.

Drug Use and Falls

Compared with controls, more cases received 2 or more drug groups of interest prior to the fall (47.9% vs 40.4%; p = 0.002). Regarding specific drug group use, patients who fell were more likely to have received antidepressants, antipsychotics, and anticonvulsants. Patients in the control group were more likely to have been prescribed benzodiazepines (Table 2). There was no difference between groups with respect to the use of short- versus long-acting benzodiazepines.

Table 1. Time of Fall in Relation to Length of Stay

Parameter	Pts., n (%)
Time from admission to fall, wk	
≤1	366 (57.6)
2–3	193 (30.4)
≥4	76 (12.0)
Time from fall to discharge, wk	
≤1	421 (66.3)
2–3	153 (24.1)
≥4	61 (9.7)

Table 2. Comorbidities and Drug Groups

Value	Cases (n = 635) n (%)	Controls (n = 1270) n (%)	p Value
Comorbidities			
cardiac arrhythmias	193 (30.4)	340 (26.8)	0.09
COPD	124 (19.5)	235 (18.5)	0.59
congestive heart failure	208 (32.8)	342 (26.9)	0.008
dementia	39 (6.1)	30 (2.4)	<0.001
diabetes	247 (38.9)	408 (32.1)	0.003
GI disorders	103 (16.2)	166 (13.1)	0.06
ischemic heart disease	133 (20.9)	267 (21.0)	0.96
pneumonia	87 (13.7)	105 (8.3)	<0.001
Drug groups			
antiarrhythmics	317 (49.9)	629 (49.5)	0.87
anticonvulsants	99 (15.6)	130 (10.2)	0.001
antidepressants	183 (28.8)	245 (19.3)	<0.001
antihistamines	72 (11.3)	164 (12.9)	0.32
antipsychotics	103 (16.2)	163 (12.8)	0.04
benzodiazepines	152 (23.9)	398 (31.3)	0.001
other CNS agents	7 (1.1)	8 (0.6)	0.27

CNS = central nervous system; COPD = chronic obstructive pulmonary disease; GI = gastrointestinal.

Regression Analysis

A univariate logistic regression was conducted first to determine which independent variables to enter into the multivariate regression. The following variables were significant at p less than 0.1: race, benzodiazepines, antidepressants, anticonvulsants, antipsychotics, cardiac arrhythmias, congestive heart failure, dementia, diabetes, gastrointestinal disease, and pneumonia. A multivariable logistic regression was then conducted using the significant variables from the univariate regressions. Table 3 lists the model output. The largest risk factor for falling in patients with CKD was having dementia as a comorbidity. Other comorbidities that were significant were pneumonia, cardiac arrhythmias, gastrointestinal disease, and diabetes. Drugs associated with a significantly increased risk of falling were antidepressants, and anticonvulsants.

Discussion

We found that the risk of falling was highest in patients with dementia as a comorbidity. It has been established in previous studies that patients who are confused or those with dementia are more prone to fall.[5,13-15] The psychologic and neurologic impact of this disease causes patients to be more liable to impaired judgment, visual disturbances, and confusion. In our study, more patients in the case group were diagnosed with dementia compared with those in the control group; however, the overall frequency of this comorbidity was low. Nonetheless, it remained a strong predictor. We identified other comorbidities that have been reported in other studies to increase the likelihood of experiencing a fall, including cardiac arrhythmias and diabetes.[16-18] Patients with a diagnosis of pneumonia were also at risk; however, we could find no published studies to confirm this finding.

We found that CKD patients treated with antidepressants or anticonvulsants were at an increased risk for an in-hospital fall. Antidepressant use has been shown to be an important independent predictor of falls[11,15,16,18-20]; however, only one other small study[13] has reported anticonvulsant

use as a risk. The findings that anticonvulsants may increase fall risk is of concern due to the increasing use of these agents for off-label indications. Since it may be impractical to avoid central nervous system active drugs in particular patients, precautions should be taken to reduce fall risk in patients receiving these medications. An unusual finding in our study was that use of benzodiazepines reduced the risk of an in-hospital fall. This is contrary to other reports.[11,12] We investigated the possible reasons for this finding, such as difference in the use of short-acting versus long-acting agents, doses, length of therapy, and number of doses prior to the fall. No significant differences could be found between the 2 groups. Gales and Menard[12] also investigated the relationship between benzodiazepine half-life and dosage and risk of falling in hospitalized elderly patients and found no differences.

Although our study focused on drugs and comorbidities that increase the risk of an in-hospital fall, there are other modifiable factors that contribute to fall risk. We found that the most common (40%) location for an in-hospital fall was next to the bed. Prevention efforts should also focus on assisting patients while ambulating and modifying environmental risks such as poor lighting, slippery floors, high beds, and lack of grab bars.[21]

Thoughtful consideration should be given to the findings of our study due to several limitations. First, we were unable to determine the thoroughness of the RMD for capturing patient falls. In addition, information on the outcome of the patient fall was commonly missing from this database. With respect to the case–control design, we were unable to match patients on severity of illness; this could have an important impact on our findings. We were also unable to determine the fall history of each patient prior to the hospitalization.

Conclusions

For patients with CKD, the risk of experiencing an in-hospital fall was highest for those with dementia. This study also confirms that patients taking antidepressants are at increased risk. Confirmatory studies are needed to support other important risk factors identified in this study, such as use of anticonvulsants and diagnosis of pneumonia. Patients with CKD who enter hospitals and have these additional risk factors should be targeted for a fall prevention program.

Table 3. Logistic Regression for Fall Risk					
Variable	β Value	SE	p Value	OR	95% CI
Anticonvulsants	0.42	0.15	0.005	1.52	1.13 to 2.03
Antidepressants	0.50	0.12	<0.001	1.65	1.32 to 2.08
Benzodiazepines	−0.38	0.11	0.001	0.69	0.55 to 0.86
Cardiac arrhythmias	0.25	0.11	0.026	1.28	1.03 to 1.59
Dementia	0.97	0.26	<0.001	2.63	1.60 to 4.33
Diabetes	0.27	0.10	0.010	1.31	1.07 to 1.60
GI disease	0.34	0.14	0.014	1.41	1.07 to 1.85
Pneumonia	0.54	0.16	0.001	1.72	1.27 to 2.35
GI = gastrointestinal.					

Mallik V Angalakuditi BSPharm PhD, at time of writing, Research Fellow, School of Pharmacy, University of Pittsburgh, Pittsburgh, PA; now, Manager, Global Health Economics, ConvaTec, A Bristol-Myers Squibb Co., Skillman, NJ

Joseph Gomes PharmD MS, Medical Liaison, Medical Affairs, UCB Inc., Antioch, IL

Kim C Coley PharmD, Associate Professor, Department of Pharmacy and Therapeutics, School of Pharmacy, University of Pittsburgh, Pittsburgh, PA

Reprints: Dr. Coley, Department of Pharmacy and Therapeutics, University of Pittsburgh, 921 Salk Hall, 3501 Terrace St., Pittsburgh, PA 15261, coley@pitt.edu

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Impacto del uso de Medicamentos y de las Comorbilidades Sobre las Caídas en el Hospital de Pacientes con Enfermedad Crónica del Riñón

MV Angalakuditi, J Gomes, y KC Coley

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EXTRACTO

TRASFONDO: Las caídas en el hospital constituyen un grave problema en las instituciones de cuidado de salud y contribuyen a la morbilidad y mortalidad en dicho escenario. Anteriormente se ha encontrado que los pacientes con enfermedad crónica del riñón tienen mayor riesgo de sufrir una caída en el hospital.

OBJETIVO: Evaluar la asociación entre las comorbilidades, el uso de medicamentos y el riesgo de caídas en el hospital de pacientes adultos con enfermedad crónica del riñón.

MÉTODOS: Se llevó a cabo un estudio retrospectivo de casos y controles con pacientes de enfermedad crónica del riñón hospitalizados entre 01/01/98 y 30/06/03. Los casos incluyeron pacientes de 18 años de edad o más, hospitalizados por más de 24 horas. Por cada caso, se identificaron 2 controles que fueron pareados por enfermedad crónica del riñón, edad y género. La información sobre comorbilidades y uso de medicamentos se recopiló de un archivo electrónico de datos médicos. Las pruebas estadísticas realizadas fueron pruebas T, Chi Cuadrado, y regresión logística multivariable. Se utilizó como variable dependiente el evento de una caída y como covariables la raza, comorbilidades, y grupos de medicamentos.

RESULTADOS: Hubo 635 casos de caídas que cumplieron con los criterios del estudio. El promedio de edad fue 68 ± 15 años, 54% eran féminas, y 82% eran caucásicos. En el análisis de regresión fueron incluidos 1270 controles pareados con enfermedad crónica del riñón. Las comorbilidades que incrementaron la probabilidad de sufrir na caída en el hospital fueron demencia (Razón de Oportunidades 2.6), pulmonía (Razón de Oportunidades 1.7), enfermedad gastrointestinal (Razón de Oportunidades 1.4), y diabetes (Razón de Oportunidades 1.3). Los medicamentos asociados con una caída en el hospital fueron antidepresivos (Razón de Oportunidades 1.7) y anticonvulsivos (Razón de Oportunidades 1.5).

CONCLUSIONES: Varias comorbilidades, especialmente demencia, aumentan el riesgo de los pacientes de enfermedad crónica del riñón de sufrir una caída en el hospital. Los medicamentos que colocan a los pacientes de enfermedad crónica del riñón en riesgo incluyen antidepresivos y anticonvulsivos.

Traducido por Ana E Velez

L'Impact de l'Utilisation des Médicaments et des Comorbidités sur les chutes chez les Patients Hospitalisés avec une Insuffisance Rénale Chronique

MV Angalakuditi, J Gomes, et KC Coley

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RÉSUMÉ

OBJECTIF: Évaluer l'association entre l'utilisation des médicaments et les comorbidités au niveau du risque de chutes chez des patients hospitalisés avec insuffisance rénale chronique.

MÉTHODES: Une étude rétrospective de type cas-témoin a été effectuée chez les patients avec insuffisance rénale chronique entre les années 01/01/98 et 06/30/03. Les facteurs d'inclusion comprenaient les patients de plus de 18 ans et hospitalisés pendant plus de 24 heures et ayant eu un chute durant leurs hospitalisations. Pour chaque cas, 2 cas-témoins ont été identifiés et appariés pour l'insuffisance rénale chronique, l'âge et le sexe. Les données concernant les comorbidités et l'utilisation des médicaments ont été recueillies en utilisant d'une banque de données médicales électroniques. Les statistiques effectuées étaient le test T, le khi carré, et la régression logistique multivariable en utilisant les évènements de chutes comme étant la variable dépendante et le sexe, les comorbidités, et les différents médicaments comme étant les covariables.

RÉSULTATS: Un nombre de 635 chutes a été identifié. L'âge moyen était de 68 ± 15 années, 54% étaient de femmes, et 82% étaient de race blanche. Un nombre de 1270 groupe témoins appariés avec insuffisance rénale chronique a été inclus dans l'analyse de régression. Les comorbidités qui augmentaient le risque de chute étaient la présence de démence (OR 2,6), de pneumonie (OR 1.7), de problèmes gastro-intestinaux (OR 1.4), et de diabète (OR 1.3). Les médicaments associés avec les chutes chez les patients hospitalisés étaient les antidépresseurs (OR 1.7) et les anticonvulsivants (OR 1.5).

CONCLUSIONS: Plusieurs comorbidités, spécialement la présence de démence, augmentent le risque de chutes chez les patients hospitalisés avec insuffisance rénale chronique. Certains médicaments dont les antidépresseurs et les anticonvulsivants augmentent également le risque de chutes.

Traduit par Louise Mallet