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Original Research

A retrospective analysis of prescription medications as it correlates to falls for older adults

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Abstract

Objectives: To determine the correlation between falls and two medication factors: the class of medications and potentially inappropriate medications (PIMs) prescribed to community-dwelling older adults aged 55 and older.

Methods: Retrospective, cross-sectional study. Home health patients residing in a Texas/Mexico border community and reporting at least one fall within the past month. Medication use, medication classification, and potentially inappropriate medications (PIM) recorded by level of falls; non-fallers and recurrent fallers.

Results: Of 99 participants, 13.1% reported falling once and 86.9% reported two or more falls. Participant's average number of medications used was 10.51 (SD 5.75) with 93.9% having four or more prescribed medications. Average number of PIMs prescribed per participant was 1.42 (SD 1.51) with at least one PIM prescribed to 65.6% of participants. Twenty three out of 83 identified classes of prescribed medications met criteria for the study's analyses but resulted in no significant association to falls when comparing NF to RF. Agents acting on the renin-angiotensin system and lipid modifying agents were the most frequently prescribed medication classes (N=55, 55.6%). Ibuprofen was the PIM most frequently prescribed (n=13, 13.1%). The correlation between use of a prescribed PIM and number of falls was not statistically significant (p=0.128).

Conclusions: There was no correlation between classes of medication and level of falls. Recurrent fallers were more likely to have been prescribed a PIM than non-fallers (not significant). Although the analyses conducted for this study did not result in statistical significance, the high prevalence of polypharmacy and prescribed PIMs observed in these participants warrants a thorough review of medications to reduce fall risks among older adults.

Keywords

Inappropriate Prescribing; Potentially Inappropriate Medication List; Accidental Falls; Aged; Middle Aged; Medical Audit; Cross-Sectional Studies; Texas

INTRODUCTION

Falls among older adults are commonly assumed to be a natural part of the ageing process. While older age may increase the risk of falls, environmental components, health-related risks that can impair balance such as vertigo, and certain medications are other factors that contribute to falls in older adults.¹ Polypharmacy, the use of four or more prescribed medications, has also been associated with an increased risk of falls.^{2,3} However, medication use is often overlooked by healthcare professionals.⁴ This is relevant given that the number of older adults is increasing in the United States (U.S.) and given that polypharmacy is an increasing trend among older adults.

In a 2008 study conducted by the American Society of Consultant Pharmacist Foundation, 75% of older adults took one or more prescription medications and 25% took five or more drugs regularly.⁵ Additionally, the number of medications prescribed tends to increase as adults grow older.⁶

Beyond the number of medications that an elderly patient is taking, it is important to consider the appropriateness of drug therapy, given that polypharmacy also increases the risk of adverse effects. These adverse effects may be due to physiological changes associated with the ageing process such as decreased drug metabolism or reduced renal function. Adverse effects may also result from medication nonadherence; either by choice or because of memory loss. Regardless of the reasons that may contribute to adverse effects, these adverse effects can result in mechanisms that increase the likelihood of falling such as dizziness, orthostatic hypotension, sedation, and confusion.^{1,7} Therefore, it is important to consider not only the number of medications prescribed but the associated risks and benefits associated with the medications prescribed.

The American Geriatrics Society developed and updated a set of criteria by which to guide the prescribing of certain medications associated with potentially adverse events in older adults.⁸ The Beers criteria include a list of Potentially Inappropriate Medications (PIMs) to be avoided in older adults as well as drugs for which dose should be adjusted based on kidney function and based on known drug to drug interactions.⁸ The Beers criteria were developed using a rigorous systematic review process to identify and grade the level of evidence available. The evidence was also evaluated by a panel of 13 experts in geriatric care and pharmacotherapy to determine needed exceptions to the listed recommendations based on clinical relevance.⁸ A study examining the point-prevalence of the use of PIMs in

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Medicare beneficiaries aged 65 years or older in the United States in 2012 demonstrated that approximately one-third of these patients were using PIMs.⁹

Of particular interest to this study is that specific types of prescription medications have been associated with an increased risk of falling including psychotropic, ototoxic, antibiotic, antihypertensive, cardiac, and analgesic drugs.¹⁰⁻¹²

Woolcott *et al.*¹⁰ conducted a meta-analysis of studies examining the association of nine medication classes with falls among older adults. They concluded that four classes of medications were associated with falls: antidepressants [Bayesian OR=1.68, CI (1.47 – 1.91)], benzodiazepines [1.57 (1.43 – 1.72)], sedatives/ hypnotics [1.47 (1.35 – 1.62)], and neuroleptics/ antipsychotics [1.59 (1.37 – 1.83)].¹⁰

Despite the prevalence of polypharmacy and the use of PIMs in older adults and more than 10 years of research examining medications and the risk of falls¹³⁻¹⁴, there is still a gap in the literature regarding the association of falls to specific medications or polypharmacy interactions.¹⁰ This lack of evidence warrants further analysis of prescribed medications and their association to falls. Therefore, there are two objectives to this study: to analyze the correlation between classes of medications and fall occurrences among older adults; and to analyze the correlation between PIMs prescribed and fall occurrences for community-dwelling older adults.

METHODS

Study Design

This study was an analysis of data from a previously published study of falls among community dwelling older adults.¹⁵ Original data collection was approved by the Institutional Review Board (IRB) of the University of Texas at El Paso. Specific data analyzed for this study were number and types of prescribed medications (classified by Beers criteria as PIMs) and number of falls reported by community dwelling older adults.

Participants

Participants in the original study were 99 home health patients who resided in a Texas/Mexico border community

and who had reported at least one fall within the past month.¹⁵ Participant's age ranged from 55-96. Please refer to Lawson & Gonzalez¹⁵ for specific exclusionary criteria.

Medications

A comprehensive medication history was recorded for all participants including name, dose, and frequency. Data regarding medications prescribed were recorded from home health agency chart reviews (nursing intake) and patient interviews. The World Health Organization (WHO) Collaborating Center for Drug Statistics Methodology was used to determine the classification of medications.¹⁶ Only medications that could be classified according to the WHO were analyzed and therefore herbal medications were excluded. Since the conception and completion of this study, the 2012 American Geriatrics Society Beers Criteria⁸ was the prominent guideline used to screen for PIMs. The 2012 version of the Beers criteria was therefore used to identify all potentially inappropriate medications observed in each participant's medication history. Polypharmacy was defined as the use of four or more medications.

Number of Falls

A fall was defined as an unexpected event in which a person comes to rest on the ground, floor, or at a lower level. Participants were asked to report the number of falls they experienced in the past month after the meaning of a fall was explained. If there was a discrepancy between number of falls reported by participants and that recorded in their medical record, participants were contacted a second time to determine that they understood clearly what constituted a fall. The number of falls reported after clarification was the number recorded for that participant. For statistical analyses, participants were categorized as non-fallers if they reported only one fall and as recurrent fallers if they reported two or more falls.¹⁷

Statistical Analysis

Differences in medication use between non-fallers and recurrent fallers were analyzed using a two-tailed Fisher's exact test in R version 3.1.1. Analyses of medication use by level of faller were conducted for the classification of medication¹⁶ as well as by PIMs.¹⁸ A classification of medication was not included in the analyses if that class of

Table 1. Participant characteristics and the prevalence of potentially inappropriate medication use according to the 2012 Beers Criteria

| N (%) [SD] | | Participants N=99 | PIMs N=141 |
|---|------------------|----------------------|---------------|
| Gender | Females | 68 (68.7%) | 1.27 [1.28] |
| | Males | 31 (31.3%) | 1.77 [1.91] |
| Ethnicity | Mexican | 18 (18.2%) | 0.83 [0.99] |
| | Mexican-American | 60 (60.1%) | 1.38 [1.25] |
| | Other | 21 (21.2%) | 2.05 [2.25] |
| Age, y | 55-75, y | 34 (34.3%) | 1.59 [1.56] |
| | 76-85, y | 43 (49.5%) | 1.47 [1.62] |
| | 86-95, y | 21 (21.2%) | 1.10 [1.22] |
| | >95, y | 1 (1.0%) | 1.00 [0.00] |
| Number of drugs used per participant | <4 | 10.51 [5.75] | 1.42 [1.51] |
| | ≥4 | 6 (6.1%) | 89 (89.9%) |
| Number of participants with PIMs | | 93 (93.9%) | 10 (10.1%) |
| Potentially inappropriate medication (PIMs) | | 65 (65.6%) | |

Table 2. Frequency of Patients Prescribed a Category of Medication for Total Study Population and by "Falls" Group

| Drug Class ^a | Number Prescribed (%) N = 99 | Recurrent Fallers ^b N = 86 | Non- Fallers ^c N = 13 | FET ^d p value |
|--|---------------------------------|--|-------------------------------------|-----------------------------|
| Renin-angiotensin system acting agents | 55 (55.6%) | 45 | 10 | 0.136 |
| Lipid modifying agents | 55 (55.6 %) | 49 | 6 | 0.555 |
| Antithrombotic agents | 47 (47.5 %) | 41 | 6 | 1.000 |
| Beta blocking agents | 43 (43.4%) | 38 | 5 | 0.771 |
| Vitamins | 40 (40.4 %) | 34 | 6 | 0.764 |
| Diuretics | 39 (39.4%) | 31 | 8 | 0.126 |
| Peptic ulcer & gastroesophageal reflux | 39 (39.4 %) | 34 | 5 | 1.000 |
| Opium alkaloids and derivatives | 32 (32.3 %) | 30 | 2 | 0.213 |
| Calcium channel blockers | 31 (31.3%) | 27 | 4 | 1.000 |
| Blood glucose lowering drugs (excluding insulins) | 30 (30.3 %) | 27 | 3 | 0.749 |
| Other analgesics and antipyretics | 29 (29.3 %) | 28 | 1 | 0.101 |
| Anti-epileptics | 25 (25.3 %) | 23 | 2 | 0.507 |
| Mineral supplements | 25 (25.3 %) | 22 | 3 | 1.000 |
| Anti-inflammatory, anti-rheumatic, non-steroids | 24 (24.2 %) | 21 | 3 | 1.000 |
| Thyroid preparations | 24 (24.2 %) | 20 | 4 | 0.510 |
| Drugs for constipation | 23 (23.2 %) | 21 | 2 | 0.727 |
| Anti-anemic preparations | 20 (20.2 %) | 17 | 3 | 0.722 |
| Psychoanaleptics-antidepressants | 17 (17.2 %) | 15 | 2 | 1.000 |
| Antihistamines for systemic use | 16 (16.2 %) | 14 | 2 | 1.000 |
| Insulins and analogues | 15 (15.2 %) | 11 | 4 | 0.107 |
| Other drugs for obstructive airway diseases, inhalants | 14 (14.1 %) | 13 | 1 | 0.686 |
| Selective beta-2-adrenoreceptor agonists | 14 (14.1 %) | 13 | 1 | 0.686 |
| Drugs used in benign prostatic hypertrophy | 11 (11.1 %) | 11 | 0 | 0.350 |

^a Drugs are classified according to the World Health Organization Collaborating Center for Drug Statistics Methodology.^{15, 6} ^b Recurrent fallers reported two or more falls in past month. ^c Non-fallers reported one fall in last month. ^d Fishers two-tailed exact test.

medication was prescribed to fewer than ten participants. An analysis was also not conducted for any specific PIMs if it was prescribed to fewer than four participants. Significance at $p < 0.05$ was assumed.

RESULTS

Of the 99 participants, 13 (13.1%) were classified as non-fallers (reported only one fall) and 86 (86.9%) were classified as recurrent fallers (reported two or more falls). The study population was primarily female (68.7%) and Mexican-American (60.1%). See Table 1 for participant characteristics.

Ninety-three (93.9%) participants had four or more prescribed medications with an average of 10.51 (SD 5.75) medications used by study participants. Additionally, 65 (65.6%) of participants had at least one PIM prescribed with the average of 1.42 (SD 1.51) PIMs prescribed to study participants.

Of the 83 identified classes of prescribed medications only 23 met the criteria to be included in this study's analyses. Of the 23 medication classes analyzed, there was no significant association to increased number of falls when comparing non-fallers to recurrent fallers (see Table 2). Agents acting on the renin-angiotensin system and lipid modifying agents were equally the two most often prescribed classes of medications ($n=55$, 55.6%).

Potentially Inappropriate Medications prescribed to at least four participants are listed in Table 3. Ibuprofen was the PIMs most often prescribed ($n=13$, 13.1%). The difference between the group of participants that were prescribed and not prescribed a PIM to the number of falls was not significant ($p = 0.128$). See Table 4.

DISCUSSION

Polypharmacy and the use of PIMs were highly prevalent in the study population. Most participants (94%) were prescribed four or more medications with an average of more than ten medications prescribed. This study may provide further evidence that polypharmacy is associated with falls; however a group of older adults who had never fallen was not available for comparison. All participants in the present study had reported at least one fall in the past month. It is also important to consider that all participants were home health patients because of medical complications and therefore more likely to be receiving more medications than they were before receiving home health services. However, data were not available to analyze whether PIMs were present before a reported fall or only present at the time of data collection. Patients were asked to provide a list of their current medications, but were not asked how long they had been prescribed each medication. It is also important to note that a fall was never

Table 3. Frequency of Potentially Inappropriate Medications (PIM)^a Prescribed to Study Participants

| Medication Prescribed | Frequency ^b (%) |
|-----------------------|----------------------------|
| Ibuprofen | 13 (13.1 %) |
| Gabapentin | 11 (11.1 %) |
| Sertraline | 9 (9.1 %) |
| Alprazolam | 5 (5.1 %) |
| Ranitidine | 5 (5.1 %) |
| Zolpidem | 5 (5.1 %) |
| Clonazepam | 4 (4.0%) |
| Darifenacin | 4 (4.0%) |
| Glyburide | 4 (4.0%) |
| Promethazine | 4 (4.0%) |
| Terazosin | 4 (4.0%) |

^a PIM Classified According to the 2012 Beer's Criteria. ^b Number of participants who were prescribed a PIM are not independent cases (i.e. one person may have more than one prescribed PIM).

| Table 4. Relationship Between Participants Prescribed a PIM ^a and Participants Not Prescribed a PIM by "Falls" Group | | | |
|---|---|-----------------------------------|-----------------------------|
| PIMs Prescribed | Recurrent Faller ^b N = 86 | Non-Faller ^c N = 13 | FET ^d p value |
| Prescribed PIM | 59 (90.8%) | 6 (9.2 %) | 0.128 |
| Not Prescribed PIM | 27 (79.4 %) | 7 (20.6 %) | |

^a PIM = Potentially inappropriate medication classified according to the 2012 Beers criteria. ^b Recurrent fallers -reported two or more falls in past month. ^c Non-fallers reported one fall in last month. ^d Fishers two-tailed exact test.

the reason for the referral for home health services for study participants.

Another impetus for this study was to analyze the association between drug class and fall occurrences among older adults. In this study, the four classes of medications prescribed the most were agents acting on the renin-angiotensin system (55.6%), lipid modifying agents (55.6%), antithrombotic agents (47.5%) and beta blocking agents (43.4%). Similar to the Gurwitz *et al.* study of an ambulatory adult population, cardiovascular medications were amongst the most frequently prescribed medications.¹⁹ The relevance of this is that falls are one of the adverse effects of taking cardiovascular medications. However, only a small percentage of participants in Gurwitz *et al.*¹⁹ study reported a fall. Although previous researchers have correlated specific medications to fall occurrences^{13,14,20-22}, an association between falls and class of medications was not supported in this study despite the extensive analysis of drug class.

There was also no support for an association between potentially inappropriate medications (PIMs) prescribed and fall occurrences for the 99 community dwelling older adults in this study. The majority of participants in this study had at least one prescribed PIM (65.6%). From a population-based study of community dwelling adults over the age of 65, Davidoff *et al.* (2015) reported that 42.6% of adults in general had at least one medication that met the broad definition of a potentially inappropriate medication using the 2012 Beers criteria. Therefore participants in the present study had a higher overall use of PIMS than that reported from the 2006-2010 Medical Expenditure Panel Survey used in the Davidoff *et al.*²³ analysis.

The most prevalent PIM prescribed to study participants was ibuprofen (13.1%). Similarly, nonsteroidal anti-inflammatory drugs (NSAIDs) were the most commonly prescribed PIMs reported by Davidoff *et al.*²³ The effects exerted by NSAIDs on the central nervous system can include sedation, drowsiness, somnolence, dizziness, lightheadedness, or hypotension, thereby increasing the risk for falls.²⁴⁻²⁶ However, in a systematic review, nine of the 13 studies showed no statistically significant increased risk of falls with NSAID use in the elderly.²⁷ Furthermore, there is limited evidence of a causal relationship between use of specific NSAIDs and falls.²⁴ Other frequently used PIMs reported for study participants included gabapentin, sertraline, and alprazolam. These medications are identified as PIMs due to the high risk of adverse drug events including a high risk of falls and fractures.⁸

Although more participants in the recurrent faller group were prescribed a PIM compared to those in the non-faller group, the difference was not statistically significant in this study. However, study limitations need to be considered.

One analysis not undertaken in this study was the drug interactions between medication classes rather than just the use of any one specific PIM. Therefore, certain combinations of medications would make it more likely that a patient would be at increased risk of falling. For example, benzodiazepines taken in combination with other medications have been reported to result in falls but not when taken without other medications.^{28,29} In one study, 71.2% (790/1110) of participants that experienced an injury were using a benzodiazepine in combination with other drugs versus only 4.3% (320/7522) of participants that experienced an injury who were using a benzodiazepine with no other drug use. The most frequently prescribed benzodiazepines to the present study participants were alprazolam and clonazepam. Additionally, patients were not asked about herbal medications they may have been taking and therefore not considered in this study. It is not known if ingredients in herbal medications interact with prescribed medications that could contribute to the increased risk of falls.

Another limitation to this study was that participants were already receiving home health intervention due to an identified medical crisis. It is possible that adjustments had already been made to medication regimens as a result of the home health interventions and that medications that may have contributed to the fall were removed from the patient's record by the time that data collection was conducted. Finally, blood pressure control in patients on antihypertensive medications and timing of medication administration and falls was not assessed. As a result, it is not possible to make any conclusions regarding falls and blood pressure control in this sample of patients in which the use of antihypertensive, specifically agents acting on the renin-angiotensin system was common.

As stated previously, adverse drug interactions have been correlated with falls in earlier studies of community dwelling older adults.¹⁹ Therefore, preventive strategies to decrease the risk of falls in this patient demographic should be implemented and patients should be monitored during their course of care. For example, the results of the present study confirmed that the use of antihypertensive medications (agents acting on the renin-angiotensin system and beta blocking agents) is very common in older adults. Monitoring a patient's blood pressure response to these medications is critical for ensuring that hypotension does not contribute to the potential for falls. This is especially important when doses are changed or additional medications that affect blood pressure are added to a medication regimen.

Assessing the presence of side effects to medications is also extremely important. It should not be assumed that a patient will report these side effects to their provider without specific probing. A study by Steinman *et al.*³⁰ demonstrated that 31% of patients living in outpatient

settings did not report adverse symptoms or side effects to their physicians. Patients need to be educated on symptoms of orthostasis and adverse drug effects for all medications including antihypertensive medications that may cause falls.³⁰ Furthermore, the use of PIMs in older adults is a common phenomenon. It is essential for healthcare providers to identify PIMs when reviewing medication regimens of older adults in order to inform prescribers to consider the use of alternative medications that could reduce the risk of falls to this vulnerable population. Due to polypharmacy and increase risk for falls, medication reconciliation and comprehensive medication review are essential to help prevent and reduce the risk for falls. Many coalitions and governmental agencies have developed toolkits that help to identify patients who are at a risk for falls. These tool kits can be incorporated into primary care settings to identify patients at risk and modifiable risk factors and offer effective interventions to prevent falls.

By the time of completion of the study, an updated version of the Beers criteria has been published. The updated criteria contain some new changes that were not previously outlined in the 2012 Beers criteria. This may necessitate an additional follow-up study using the updated criteria. The main updates of the 2015 Beers Criteria were drug-drug interactions, renal-dose adjustments, and new medication/classes of medications that should be avoided in geriatric patients.

A final limitation of the present study is that all participants had experienced at least one fall. Although people who had experienced only one fall could be classified as non-fallers, it did not change the fact that there were not an equivalent number of participants in either group. Additionally, the

original study was conducted with the intent of examining a population of patients who reported falling in the past month.¹⁵ Therefore, medication use for participants who were medically stable and who had never fallen was not possible.

CONCLUSIONS

The findings in this study did not confirm results from previous studies demonstrating correlations with certain medication classes and fall risks among older adults. Limitations in the ability to consider the effects of potential drug interactions and pharmacodynamic effects of medications on these older adult patients may have contributed to the lack of correlation noted between classes of medications and falls. Although the subjects experiencing recurrent falls were more likely to have been prescribed a PIM, this finding was also not statistically significant in this investigation. However, consideration of the potential for falls associated with medication use in older adults is still warranted due to the high prevalence of polypharmacy in this demographic group and the negative sequelae of falls. Future investigations should take into consideration the effects of interactions medications may play in putting older adults at risk for falls.

CONFLICT OF INTEREST

None.

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