HHS Public Access

Author manuscript

J Am Geriatr Soc. Author manuscript; available in PMC 2016 February 19.

Published in final edited form as:

J Am Geriatr Soc. 2016 February ; 64(2): 401–408. doi:10.1111/jgs.13922.

Recent Literature on Medication Errors and Adverse Drug Events in Older Adults

Jennifer G. Naples, PharmD^{1,2,3}, Joseph T. Hanlon, PharmD, MS^{1,2,3,4,5,6}, Kenneth E. Schmader, MD^{7,8}, and Todd P. Semla, MS, PharmD^{9,10}

¹Department of Medicine (Geriatrics), School of Medicine, School of Pharmacy, University of Pittsburgh, Pittsburgh, Pennsylvania

²Department of Pharmacy and Therapeutics, School of Pharmacy, University of Pittsburgh, Pittsburgh, Pennsylvania

³Center for Health Equity Research and Promotion, Veterans Affairs Pittsburgh Healthcare System, Pittsburgh, Pennsylvania

Corresponding Author: Todd Semla, MS, PharmD, Pharmacy Benefits Management Services, Department of Veterans Affairs, Hines, Illinois; Associate Professor, Clinical, Departments of Medicine and Psychiatry & Behavioral Sciences, Feinberg School of Medicine, Northwestern University, Chicago, IL 6061; Telephone #: 708-786-7976; Fax #: 708-786-7891; t-semla@northwestern.edu.
Alternate Corresponding Author: Dr. Naples at Department of Medicine (Geriatrics), University of Pittsburgh, Kaufmann Medical Building, Suite 514, 3471 Fifth Ave, Pittsburgh, PA 15213; Telephone #: 412-864-2082; Fax #: 412-692-2370; jgn13@pitt.edu

Conflict of Interest:

Dr. Naples, Dr. Hanlon and Dr. Schmader have no conflicts to report.

Conflict of Interest Disclosures:

Elements of Financial/Personal Conflicts	All authors		Dr. Naples		Dr. Hanlon		Dr. Semla		Dr. Schmader	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Employment or Affiliation		X		X		X		X		X
Grants/Funds		X		X		X		X		X
Honoraria		X		X		X		X		X
Speaker Forum		X		X		X		X		X
Consultant		X		X		X		X		X
Stocks		X		X		X		X		X
Royalties		X		X		X		X		X
Expert Testimony		X		X		X		X		X
Board Member		X		X		X		X		X
Patents		X		X		X		X		X
Personal Relationship		X		X		X		X		X

Author Contributions: Drs. Naples, Hanlon, Semla, and Schmader reviewed abstracts of all identified articles and reached consensus about which to highlight. All authors were involved in the writing/editing of the manuscript. Drs. Hanlon and Naples formatted the Appendix and all authors critically reviewed a draft of the manuscript and approved the final version.

Disclaimer: The opinions expressed are those of the authors and not necessarily those of the U.S. Government or the U.S. Department of Veterans Affairs.

⁴Department of Epidemiology, School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania

⁵Clinical and Translational Science Institute, University of Pittsburgh, Pittsburgh, Pennsylvania

⁶Geriatric Research Education and Clinical Center, Veterans Affairs Pittsburgh Healthcare System, Pittsburgh, Pennsylvania

⁷Department of Medicine (Geriatrics), School of Medicine, Duke University Medical Center, Durham, North Carolina

⁸Geriatric Research Education and Clinical Center, Durham Veterans Affairs Medical Center, Durham, North Carolina

⁹Pharmacy Benefits Management Services, Department of Veterans Affairs, Hines, Illinois

¹⁰Departments of Medicine, and Psychiatry and Behavioral Science, Feinberg School of Medicine, Northwestern University, Chicago Illinois

Abstract

Medication errors and adverse drug events are common in older adults, but locating literature addressing these issues is often challenging. The objective of this article was to summarize recent studies addressing medication errors and adverse drug events in a single location to improve accessibility for individuals working with older adults. The authors conducted a comprehensive literature search for studies published in 2014 and identified 51 potential articles. After critical review, 17 studies were selected for inclusion based on innovation, rigorous observational or experimental study designs, and use of reliable, valid measures. Four articles characterizing potentially inappropriate prescribing and interventions to optimize medication regimens were annotated and critiqued in detail. We hope that health policy makers and clinicians find this information helpful in improving the quality of care for older adults.

INTRODUCTION

Many older adults have multiple medical conditions commonly treated with multiple medications.¹ Indeed, this past year we learned that over 50% of older adults in the United States take four or more medications, which is higher than rates reported in Canadian or the United Kingdom.² Unfortunately, the use of multiple medications can lead to medication errors and adverse drug events.¹ To address these unintended negative consequences, it is important to answer certain clinical questions: How is drug therapy being used in older adults? If potential medication errors are detected, what are the outcomes of drug therapy? And finally, are there interventions that are effective in modifying the use and outcomes of drug therapy?³

Unfortunately, literature addressing these questions is challenging to locate due dispersed publication worldwide and a lack of specific, standardized search terms with which to query journals. Therefore, the editors of the *Journal of the American Geriatrics Society* have graciously permitted us to publish a compilation of the latest literature regarding medication errors and adverse drug events in older adults for the third consecutive year. The objective

of this article is to summarize recent studies in a single location to improve accessibility to individuals working with older adults. We hope you find the following articles informative and pertinent to your practice.

METHODS

A search of Medline® and Google Scholar™ restricted to 2014 was conducted using a combination of the terms: adverse drug events, adverse drug reactions, adverse drug withdrawal events, therapeutic failure, aged, elderly, drug-related problems, medication-related problems, medication errors, polypharmacy, unnecessary drug use, suboptimal or inappropriate prescribing, under prescribing/utilization, medication non-adherence, medication administration or dispensing errors, medication monitoring omissions, and medication misadventures. A manual search for relevant articles from the *New England Journal of Medicine*; *Age and Aging*; *Annals of Internal Medicine*; *Annals of Pharmacotherapy*; *Clinical Pharmacology and Therapeutics*; *Journal of the American Medical Association*; *Journal of the American Medical Association Internal Medicine*; *Journal of Gerontology: Medical Science*; *Lancet*; and *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy* was also conducted. Additional articles identified by the authors were also considered.

The abstracts of identified articles were independently reviewed by two authors (JGN, JTH) for relevance. A preliminary list of potential articles for inclusion was then reviewed by all authors and consensus was reached regarding which to highlight. Preference was given to studies that were innovative and used rigorous observational or experimental study designs and reliable, valid measures. Review articles without an accompanying meta-analysis or articles focused exclusively on drug efficacy/effectiveness were excluded. Also excluded were articles published in the *Journal of the American Geriatrics Society*, *Consultant Pharmacist*, and *Drugs and Aging* as these journals are obvious places for readers to easily locate relevant material.

RESULTS

A preliminary list of 51 articles was developed. After each author reviewed the abstracts of these articles and consensus was reached regarding which articles to highlight, a total of 17 remained. Below we annotate and critique four studies.⁴⁻⁷ The remaining article abstracts can be found in the online Appendix by categories, alphabetized by the first author's last name.

Article 1: Improving Inappropriate Prescribing

The Eliminating Medications Through Patient Ownership of End Results (EMPOWER) trial was a pragmatic cluster randomized clinical trial in Montreal, Canada, designed to evaluate the effectiveness of personalized, direct patient education on benzodiazepine (BZD) discontinuation or dose reduction (defined as 25% decrease in dose sustained for 3 consecutive months) in adults older than 65. Patients taking at least 5 medications, including one chronic benzodiazepine, were recruited. The intervention group (n=148) received information about potential harms of BZD as well as a visual 21-week step-wise tapering

protocol, while the control group (n=155) received usual care. At 6 months, 27% of the intervention group had achieved complete BZD cessation and an additional 11% had achieved dose reduction, compared with 5% and 6%, respectively, of the control group. Overall, nearly 4 patients would need to receive the intervention to achieve BZD discontinuation or dose reduction over 6 months. The authors concluded “direct-to-consumer education effectively elicits shared decision making around the overuse of medications that increase the risk of harm in older adults.”

“Deprescribing” is an increasingly important concept that may enable providers to avoid clinical inertia leading to persistent use of potentially inappropriate medications (PIM).^{8,9} Although two other studies addressing BZD discontinuation using different interventions have been published, neither yielded statistically significant results.^{10,11} This study is important in that it is the first examining the role of the patient in deprescribing BZD, and demonstrates that shared decision making is an effective strategy for reducing PIM use. Given appropriate information, older adults can play an integral role in identifying situations of overtreatment and can initiate cessation of potentially harmful medications. Even if there was no ultimate attempt to taper the BZD, 62% of participants in this study communicated concerns with their healthcare provider.

As with any study, however, there are some potential concerns. It is important to note that among individuals in the intervention group, adverse drug withdrawal events (e.g., rebound insomnia and anxiety) were high at 42%. However, it is unclear whether a valid instrument was used to measure insomnia adverse drug withdrawal events, and the rate of withdrawal events in the control group was not provided. The high withdrawal rate may be secondary to the rapidity of the tapering protocol or lack of supervision by a healthcare provider (38% of individuals attempting a taper did not discuss their intention with a physician or pharmacist). Notably, 5% of those individuals who discontinued a BZD received a highly-anticholinergic PIM drug (i.e., paroxetine, amitriptyline) as a substitute. As a next step, it would have been helpful to determine if the reduction in BZD use associated with this intervention had a favorable impact on other clinical outcomes such as cognitive impairment and falls.

Article 2: Documenting Potentially Unnecessary Prescribing

Tjia et al. conducted a national cross-sectional study of data from 460 nursing homes to determine the rate of potentially unnecessary medications in residents with advanced dementia and to identify associated resident- and facility-level factors.⁵ Unnecessary medications were defined as those considered “never appropriate” for use in advanced dementia according to explicit criteria developed using a Delphi survey.¹² More than half (53.9%) of nursing home residents with advanced dementia received at least 1 potentially unnecessary medication. Acetylcholinesterase inhibitors, memantine, and lipid-lowering agents were the most common unnecessary medications. Interestingly, living in a facility where at least 10% of residents had feeding tubes was the only factor associated with an increased risk of unnecessary drug use. The authors concluded “most nursing home residents with advanced dementia receive medications with questionable benefit that incur substantial associated costs.”

Unnecessary drug use in those with limited life expectancy has drawn considerable attention over the past decade.^{12–16} The current study is among the first to examine this issue in such a large representative sample (n=5,406). The only prior study (published by Colloca et al.) included 1,449 Italian nursing home residents with dementia.¹⁷ Interestingly, that study employed the same explicit criteria but found a lower rate of potentially unnecessary drugs (26.8%). The most common potentially unnecessary medications were the same as in the current study, with the exception of a slightly higher rate for antiplatelets (9.9% vs 7.2%, respectively). In both studies residents with diabetes, heart failure, stroke, or a recent hospitalization had a higher risk for unnecessary medications. In the study by Tjia, a physician visit within the past 14 days was also associated with increased risk of questionable medications, whereas Colloca found having a geriatrician on site was protective.

There are potential limitations to both studies. The cross-sectional design does not allow one to know when unnecessary drugs were prescribed (e.g., prior to or during the nursing home stay). Moreover, the criteria used to measure unnecessary drug use did not include certain medications classes other experts consider relevant, including cardiovascular drugs (i.e., angiotensin converting enzyme inhibitors, anticoagulants, angiotensin receptor blockers, antihypertensives), anticholinergics (e.g., antvertigo, tricyclic antidepressants), anti-infectives, bisphosphonates, central nervous system stimulants, diabetes drugs, expectorants, genitourinary antispasmodics, minerals, proton pump inhibitors, and vitamins.^{14–16} Using only explicit criteria as opposed to valid and reliable implicit measures such as the Medication Appropriateness Index does not take patient specific factors or patient/caregiver preferences into account. Finally, neither study examined the consequences of discontinuing these questionable medications. It is encouraging, however, that one recent reverse randomized controlled trial discontinuing lipid-lower agents in individuals with end stage cancer did not result in an increase in adverse cardio/cerebrovascular events.¹⁸

Article 3: Determining the Epidemiology of Medication Non-Adherence

Tamblyn and colleagues examined the occurrence of primary nonadherence (defined as having a prescription written but not filled at the pharmacy within 9 months) in 15,961 older Canadians receiving care from 131 primary care physicians. Almost a third (31.3%) of new prescriptions were not filled, with highest nonadherence for medication classes used to treat headache, ischemic heart disease, and depression. Primary non-adherence was less likely among individuals who were older in age, received prescriptions without copayments, and had more visits with the prescribing physician. The authors concluded “primary nonadherence is common and may be reduced by lower drug costs and payments, as well as increased follow-up care with prescribing physicians for patients with chronic conditions.”

This is one of the first studies examining primary nonadherence in elderly patients across medical conditions and medication classes. Primary medication nonadherence is concerning in that it may lead to greater health care utilization, morbidity, and mortality. This study did not measure whether primary nonadherence resulted in these adverse health outcomes. It is important to keep in mind, however, that some nonadherence may have been “intelligent” if the prescription was for a PIM where risk associated with its use may outweigh the benefit;

in this situation, fewer adverse health outcomes may be expected. Higher rates of nonadherence with more expensive medications is consistent with another recent study highlighted in the Appendix, and may be due to the fact that physicians often do not know the costs of medications.^{19,20}

Article 4: Reducing a Specific Type of ADR - Drug Induced Falls

A randomized controlled pilot study by Michalek et al. examined the impact a drug regimen review and corresponding feedback to the prescribing physician had on suboptimal prescribing and falls. Of the 114 older hospitalized patients from Germany enrolled in this study, 56 patients were randomized to have their medication profiles reviewed and medications adjusted based on the Fit fOR The Aged (FORTA) criteria. Compared to the control group, the intervention group had significantly lower rates of over-prescribing (i.e., unnecessary medications) and under-prescribing (i.e., omissions of necessary drugs). Additionally, fewer patients in the intervention group versus control group experienced falls (3.4 % vs 21.4 %, respectively). The authors concluded that although medication quality improved and fall rate decreased in the intervention group, “[t]hese encouraging results must be interpreted carefully.”

This study joins 13 other randomized controlled trials designed to reduce potentially inappropriate prescribing and subsequent falls in older adults.^{21–32} Including the current study, only 7 have achieved these objectives.^{23,24,26,29,30,32} Moreover, the current trial is the only successful single intervention study conducted in a hospital, where falls are common and can lead to considerable morbidity and additional health care costs.³³

However, like all studies this one has some limitations. Although not possible in a pilot study in one hospital, future multicenter studies should randomize physicians and use them as the unit of analyses to determine the impact of the intervention. Secondly, the FORTA criteria may be obsolete with the recent publication of two new European measures for inappropriate prescribing.^{34,35} Finally, as this study was conducted in one hospital in Germany, generalizability to other health care settings or other health care systems is unknown.

CONCLUSIONS

Although there were a number of articles published this year that addressed medication errors and adverse drug events in older adults, the selected articles describe particularly interesting advancements. One study highlights a novel intervention that recruits patient participation to withdraw potentially inappropriate benzodiazepines. Another demonstrates that medications unlikely to improve quality of life are commonly prescribed to older adults with limited life expectancy. The third study quantifies primary medication nonadherence in older adults and examines factors associated with this particular drug-related problem. A final intervention study in hospitalized elders showed that reviewing drug regimens and providing feedback to physicians not only improved suboptimal prescribing, but also reduced the rate of falls. We hope that health policy makers and clinicians find this information helpful in improving the quality of care for older adults.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGMENTS

Dr. Semla serves on the Omnicare, Inc. Pharmacy and Therapeutics Committee and is an author and editor for LexiComp®; his spouse is an employee of AbbVie and owns stock in AbbVie, Abbott Labs, and Hospira.

Funding Sources: Dr. Naples's fellowship is supported by a National Institute of Aging grant (T32-AG021885). Dr. Hanlon is supported by National Institute of Aging grants (P30AG024827, K07AG033174, and R01AG037451), a grant from the Donoghue Foundation, a grant from the Agency for Healthcare Research and Quality (R18 HS023779), and VA Health Services Research and Development Service Merit awards (IIR 12-379 and IIR 14-297). Dr. Schmader is supported by a National Institute of Aging Grant (P30AG028716).

Sponsor's Role: No entity sponsored this manuscript.

REFERENCES

1. Maher R, Hanlon J, Hajjar ER. Clinical consequences of polypharmacy in elderly. *Exp Opin Drug Safety*. 2014; 13:57–65.
2. Osburn R, Moulds D, Squires D, Doty M, Anderson C. International survey of older adults finds shortcomings in access, coordination, and patient-centered care. *Health Aff*. 2014; 33:2247–2255.
3. Stewart RB. The clinical pharmacist in drug research and development. *Pharmacoepidemiology. Drug Intell Clin Pharm*. 1987; 21:121–124. [PubMed: 3816571]
4. Tannenbaum C, Martin P, Tamblyn R, Benedetti A, Ahmed S. Reduction of inappropriate benzodiazepine prescriptions among older adults through direct patient education: the EMPOWER cluster randomized trial. *JAMA Intern Med*. 2014; 174:890–898. [PubMed: 24733354]
5. Tjia J, Briesacher BA, Peterson D, Liu Q, Andrade SE, Mitchell SL. Use of medications of questionable benefit in advanced dementia. *JAMA Intern Med*. 2014; 174:1763–1771. [PubMed: 25201279]
6. Tamblyn R, Egale T, Huang A, Winslade N, Doran P. The incidence and determinants of primary nonadherence with prescribed medication in primary care: a cohort study. *Ann Intern Med*. 2014; 160:441–450. [PubMed: 24687067]
7. Michalek C, Wehling M, Schlitzer J, Frohnhofen H. Effects of “Fit for The Aged” (FORTA) on pharmacotherapy and clinical endpoints – a pilot randomized controlled study. *Eur J Clin Pharmacol*. 2014; 70:1261–1267. [PubMed: 25128076]
8. Woodward MC. Deprescribing: achieving better health outcomes for older people through reducing medications. *J Pharm Pract Res*. 2003; 33:323–328.
9. Scott IA, Hilmer SN, Reeve E, et al. Reducing inappropriate polypharmacy: the process of deprescribing. *JAMA Intern Med*. 2015; 175:827–834. [PubMed: 25798731]
10. Salonoja M, Salminen M, Aarnio P, Vahlberg T, Kivela SL. One-time counselling decreases the use of benzodiazepines and related drugs among community-dwelling older persons. *Age Ageing*. 2010; 39:313–319. [PubMed: 20089547]
11. Velert Vila J, del Mar Velert Vila M, Salar Ibanez L, et al. Adecuación de la utilización de benzodiazepinas en ancianos desde la oficina de farmacia. Un estudio de colaboración médico-farmacéutico [Suitability of the use of benzodiazepines prescribed by the pharmacist in the elderly. A doctor-pharmacist collaboration study]. *Aten Primaria*. 2012; 44:402–410. [PubMed: 22023889]
12. Holmes HM, Sachs GA, Shega JW, Hougham GW, Cox Hayley D, Dale W. Integrating palliative medicine into the care of persons with advanced dementia: identifying appropriate medication use. *J Am Geriatr Soc*. 2008; 56:1306–1311. [PubMed: 18482301]
13. Tjia J, Rothman MR, Kiely DK, et al. Daily medication use in nursing home residents with advanced dementia. *J Am Geriatr Soc*. 2010; 58:880–888. [PubMed: 20406320]

14. van Nordennen RT, Lavrijssen JC, Vissers KC, Koopmans RT. Decision making about change of medication for comorbid disease at the end of life: an integrative review. *Drugs Aging*. 2014; 31:501–512. [PubMed: 24825615]
15. Parsons C, McCann L, Passmore P, Hughes C. Development and application of medication appropriateness indicators for persons with advanced dementia: a feasibility study. *Drugs Aging*. 2015; 32:67–77. [PubMed: 25480124]
16. Lindsay J, Dooley M, Martin J, et al. The development and evaluation of an oncological palliative care deprescribing guideline: the ‘OncPal deprescribing guideline’. *Support Care Cancer*. 2015; 23:71–78. [PubMed: 24975044]
17. Colloca G, Tosato M, Vetrano DL, et al. Inappropriate drugs in elderly patients with severe cognitive impairment: results from the SHELTER Study. *PLoS One*. 2012; 7(10):e46669. [PubMed: 23056394]
18. Kutner JS, Blatchford PJ, Taylor DH Jr, et al. Safety and benefit of discontinuing statin therapy in the setting of advanced, life-limiting illness: a randomized clinical trial. *JAMA Intern Med*. 2015;691–700. [PubMed: 25798575]
19. Naci H, Soumerai SB, Ross-Degnan D, et al. Medication affordability gains following Medicare Part D are eroding among elderly with multiple chronic conditions. *Health Aff*. 2014; 33:1435–1443.
20. Allan GM, Lexchin J, Wiebe N. Physician awareness of drug cost: a systematic review. *PloS Med*. 2007; 4:e283. [PubMed: 17896856]
21. Lapane KL, Hughes CM, Daiello LA, Cameron KA, Feinberg J. Effect of a pharmacist-led multicomponent intervention focusing on the medication monitoring phase to prevent potential adverse drug events in nursing homes. *J Am Geriatr Soc*. 2011; 59:1238–1245. [PubMed: 21649623]
22. García-Gollarte F, Baleriola-Júlvez J, Ferrero-López I, Cuenllas-Díaz Á, Cruz-Jentoft AJ. An educational intervention on drug use in nursing homes improves health outcomes resource utilization and reduces inappropriate drug prescription. *J Am Med Dir Assoc*. 2014; 15:885–891. [PubMed: 24895001]
23. Campbell AJ, Robertson MC, Gardner MM, Norton RN, Buchner DM. Psychotropic medication withdrawal and a home-based exercise program to prevent falls: a randomized, controlled trial. *J Am Geriatr Soc*. 1999; 47:850–853. [PubMed: 10404930]
24. Tamblyn R, Equale T, Buckeridge DL, et al. The effectiveness of a new generation of computerized drug alerts in reducing the risk of injury from drug side effects: a cluster randomized trial. *J Am Med Inform Assoc*. 2012; 19:635–643. [PubMed: 22246963]
25. Meredith S, Feldman P, Frey D, Giammarco L, Hall K, Arnold K, Brown NJ, Ray WA. Improving medication use in newly admitted home healthcare patients: a randomized controlled trial. *J Am Geriatr Soc*. 2002; 50:1484–1491. [PubMed: 12383144]
26. Weber V, White A, McIlvried R. An electronic medical record (EMR)-based intervention to reduce polypharmacy and falls in an ambulatory rural elderly population. *J Gen Intern Med*. 2008; 23:399–404. [PubMed: 18373136]
27. Blalock SJ, Casteel C, Roth MT, Ferreri S, Demby KB, Shankar V. Impact of enhanced pharmacologic care on the prevention of falls: a randomized controlled trial. *Am J Geriatr Pharmacother*. 2010; 8:428–440. [PubMed: 21335296]
28. Crotty M, Rowett D, Spurling L, Giles LC, Phillips PA. Does the addition of a pharmacist transition coordinator improve evidence-based medication management and health outcomes in older adults moving from the hospital to a long-term care facility? Results of a randomized, controlled trial. *Am J Geriatr Pharmacother*. 2004; 2:257–264. [PubMed: 15903284]
29. Zermansky AG, Alldred DP, Petty DR, et al. Clinical medication review by a pharmacist of elderly people living in care homes--randomised controlled trial. *Age Ageing*. 2006; 35:586–591. [PubMed: 16905764]
30. Pit SW, Byles JE, Henry DA, Holt L, Hansen V, Bowman DA. A quality use of medicines program for general practitioners and older people: a cluster randomised controlled trial. *Med J Aust*. 2007; 187:23–30. [PubMed: 17605699]

31. Patterson SM, Hughes CM, Crealey G, Cardwell C, Lapane KL. An evaluation of an adapted U.S. model of pharmaceutical care to improve psychoactive prescribing for nursing home residents in northern Ireland (Fleetwood northern Ireland study). *J Am Geriatr Soc.* 2010; 58:44–53. [PubMed: 20002510]
32. Frankenthal D, Lerman Y, Kalendaryev E, Lerman Y. Intervention with the screening tool of older persons potentially inappropriate prescriptions/screening tool to alert doctors to right treatment criteria in elderly residents of a chronic geriatric facility: a randomized clinical trial. *J Am Geriatr Soc.* 2014; 62:1658–1665. [PubMed: 25243680]
33. Deandrea S, Bravi F, Turati F, Lucenteforte E, La Vecchia C, Negri E. Risk factors for falls in older people in nursing homes and hospitals. A systematic review and meta-analysis. *Arch Gerontol Geriatr.* 2013; 56:407–415. [PubMed: 23294998]
34. O'Mahony D, O'Sullivan D, Byrne S, et al. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. *Age Ageing.* 2015; 44:213–218. [PubMed: 25324330]
35. Renom-Guiteras A, Meyer G, Thurmann PA. The EU(7)-PIM list: a list of potentially inappropriate medications for older people consented by experts from seven European countries. *Eur J Clin Pharmacol.* 2015; 71:861–875. [PubMed: 25967540]