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## The Impact of Family Caregivers on Potentially Inappropriate Medication Use in Non-institutionalized Older Adults with Dementia

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### Abstract

**Background**—The risk of potentially inappropriate prescription and over-the-counter medication (PIM) use in dementia patients is high. Informal caregivers often facilitate patients' use of medications, but the effect of caregiver factors on PIM use has not been a focus of prior research.

**Objective**—To examine PIM use in dementia patients and caregivers, and identify caregiver risk factors for PIM use in dementia patients.

**Methods**—We conducted a secondary data analysis of the baseline wave of the Resources for Enhancing Alzheimer's Caregiver's Health study. The sample was comprised of 566 persons with dementia aged 65 and older and their co-residing family caregiver. PIM was defined using the

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2003 Beers criteria and was examined in both dementia patients and their caregivers. Caregiver and patient risk factors included a range of socio-demographic and health variables.

**Results**—In dementia patients, 33% were taking at least 1 PIM, and 39% of their caregivers were also taking a PIM. In fully adjusted models, the following caregiver factors were associated with an increased risk of dementia patient PIM use: caregiver's own PIM use; spouse caregivers; Hispanic caregivers; and greater number of years the caregiver has lived in the United States. Increased caregiver age was associated with a decreased risk of PIM use in patients.

**Conclusions**—PIM use may be higher in dementia patients and their informal caregivers compared to the general older adult population. Further, patterns of medication use in one member of the dyad may influence PIM risk in the other dyad member. These results suggest that interventions to increase appropriate medication use in dementia patients and their caregivers should target both members of the dyad and target over-the-counter agents along with prescription medications.

### Keywords

Dementia; informal caregivers; inappropriate medications; care quality

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## INTRODUCTION

Older adults with dementia, along with their caregivers and healthcare providers, face considerable challenges in achieving optimal medication use.<sup>1</sup> While multiple medications may be needed to manage dementia and any co-existing medical conditions, prior research also suggests that increased need for multiple medications is a major risk factor for use of potentially inappropriate medications (PIMs).<sup>2</sup> A growing body of research documents negative health consequences of PIM use in older adults.<sup>3-5</sup> Exposure to PIMs may be particularly harmful in dementia patients, as many inappropriate medications may worsen cognition and work antagonistically against cholinergic-boosting medications used to treat dementia.<sup>6</sup>

The ability to independently manage medications is among the first functional losses in dementia patients. As dementia progresses, patients increasingly rely upon informal caregivers for assistance with managing medications. Prior estimates suggest across all stages of dementia, 54% of caregivers are actively involved in daily management of patient medications; in later stages of dementia the percentage exceeds 90%.<sup>7</sup> Caregivers have also been found to more accurately report care-recipient medication information compared to patients,<sup>8</sup> and caregivers report considerable strain in tasks related to patient medications.<sup>9</sup> In addition, caregivers themselves often have multiple chronic conditions and are simultaneously managing an average of 4-6 of their own medications.<sup>10</sup> While prior research has documented these challenges and the active role played by caregivers in managing patient medications, along with the influences of caregiver behavior and health on patient's use of other health services,<sup>11-14</sup> little is known about how caregivers may influence medication safety and quality in dementia patients.<sup>15</sup> Understanding how caregiver factors affect PIM use in dementia patients can inform future medication management interventions aimed at increasing appropriate medication use in both dementia patients and their informal caregivers.

The primary aim of the current study was to examine potential caregiver risk factors associated with dementia patient use of PIMs. Furthermore, prior estimates of PIM use in older adults have been limited to prescription medications, yet many PIMs are readily available over-the-counter without a prescription. Therefore, a secondary aim of this study was to document the prevalence of PIM use in both dementia patients and their informal

caregiver using all of the potential sources of prescription and non-prescription PIMs available to older adults living in the community.

## METHODS

### Sample

The sample and data were drawn from the baseline wave of Resources for Enhancing Alzheimer's Caregiver Health (REACH), a six-site, randomized caregiver intervention designed to maintain the health of caregivers of individuals with dementia. REACH was conducted from 1996-2001, and contains a baseline sample of 1,222 family caregivers of dementia patients (hereafter referred to as care-recipient). Eligibility and sample selection criteria have been described elsewhere.<sup>16</sup> Briefly, caregivers were required to be over age 21, co-residing with the care recipient, and providing care for 4 hours per day for at least 6 months. Care-recipients had to have diagnosis of probable dementia and at least one limitation in activities of daily living. Current use of prescription and non-prescription medications by both caregivers and care-recipients, defined as medications taken in past month, was documented via "brown bag" assessment conducted by trained personnel during home study visits. Caregivers were asked to make available all prescription and non-prescription medications including herbals taken by the care recipient and themselves, and trained assessors transcribed medication names from containers to data collection forms.

Because the Beers criteria were developed to identify inappropriate medications in older adults, we restricted the REACH sample to dyads where both the caregiver and care recipient were  $\geq 65$  years (final  $n = 566$  dyads).

### Measures

**Outcome Variable**—Our primary outcome of interest was care-recipient use of potentially inappropriate medications defined using the 2003 Beers criteria.<sup>17</sup> The Beers criteria define drugs that should generally be avoided because they are ineffective or pose unnecessarily high risk for older persons, and drugs that are appropriate to use in older persons only at certain doses, frequencies, or duration of therapies.<sup>18</sup> Because of inadequate availability of disease and dose information in REACH, we excluded from our analysis drug-disease PIMs and drugs defined by the Beers criteria as inappropriate only at certain doses. A dichotomous variable was constructed to indicate care recipient PIM use in the past month (0= none, 1=one or more PIMs). Additionally, we constructed an alternative measure of PIM use that excluded oral estrogens from the Beers criteria. At the time REACH data were collected (1996-2001), oral estrogens were recommended to some postmenopausal women. Since the time of the original study, however, prescribing practices for estrogens may have changed based on findings from the Women's Health Initiative in 2002.<sup>19</sup>

**Independent Variables**—Consistent with previous research on PIM use in older adults,<sup>2,20</sup> the selection of potential risk factors for care-recipient use of PIMs was guided by the Andersen Sociobehavioral Model (SBM) of health services use.<sup>21</sup> Similar to Bass and Noelker,<sup>12</sup> we adapted the SBM to incorporate both caregiver and care-recipient predisposing, enabling, and medical need factors into the model.

Predisposing variables are caregiver or care-recipient factors that increase the propensity for health service use by care-recipients, and included caregiver and care-recipient age (years), caregiver and care-recipient sex, caregiver relationship to care-recipient, caregiver education (no high school diploma or GED, high school or GED only, some college or more), caregiver race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic), and length of caregiver and care-recipient residency in the United States (years).

Enabling variables are caregiver or care-recipient factors that facilitate or impede the care-recipient access to health services. Caregiver perceived financial inadequacy was measured by response to the question: How hard is it for you to pay for the very basics like food, housing, medical care, and heating (1 = not difficult at all, 2 = not very difficult, 3 = somewhat difficult, 4 = very difficult)? Annual household income was categorized as < \$20,000, \$20,000 - \$39,999, or \$40,000. Caregiver employment status was dichotomized as not employed or retired versus employed full or part-time. Additionally, we included measures of caregiver health status as enabling variables.<sup>12</sup> Caregiver depressive symptoms were measured using scores (range 0 to 60) on the Center for Epidemiologic Studies Depression Scale (CES-D),<sup>22,23</sup> Caregiver health status was measured with a one-item global measure of self-rated health (excellent, very good, good, fair, or poor), grouped into excellent/very good/good versus fair/poor. We also included a count of seven self-reported chronic conditions: arthritis, hypertension, heart condition, prior stroke, chronic lung condition, cancer, and diabetes.

Medical need variables capture the objective and subjective health care needs of the care recipient and included a count of limitations in activities of daily living (ADL)<sup>24</sup> (range 0-6) and instrumental activities of daily living (IADL)<sup>25</sup> (range 0-9). Cognitive status was evaluated using the Mini-Mental Status Examination (MMSE; range 0-30, lower scores signify greater impairment).<sup>26</sup> The Revised Memory and Behavior Problems Checklist (RMBPC) was used to determine the total number of dementia-related behavior problems in the past week (range 0-24).<sup>27</sup> The total number of medications being taken by the care-recipient was categorized as 0-3, 4-8, or 9 or more medications.

We also explored the association between caregiver medication use and care-recipient PIM use. Specifically, we included a measures of caregiver PIM use in the past month (0= none, 1=one or more PIMs), and total number of medications being taken by the caregiver (0-3, 4-8, 9 or more).

**Data Analysis**—We used STATA 11.0 (Stata, College Station, TX) for analysis. To reclaim cases with missing data, and with less than 10% missing, we used conditional mean imputation to generate a single complete dataset.<sup>28</sup> Bivariable t-test,  $\chi^2$  test, and logistic regression were performed to examine the unadjusted association between independent variables and likelihood of care-recipient PIM use. Multiple logistic regression was then used to estimate adjusted odds ratios (ORs) and 95% confidence intervals (CIs), with standard errors adjusted for clustering in the six REACH locations. Examination of variance inflation factors (VIFs) revealed severe multicollinearity between caregiver and care-recipient sex (VIF = 10.1), and number of years lived in the United States (VIF = 6.2). Due to this overlap in variance we dropped caregiver sex and number of years care-recipient lived in the United States from the final analysis. To facilitate interpretation of model results, we calculated post-estimation discrete changes in predicted probabilities across levels of statistically significant independent variables, with confidence intervals generated via bias-corrected bootstrapping methods.<sup>29</sup> Finally, we examined the overall significance of caregiver factors by comparing the relative goodness-of-fit for two nested models via a likelihood ratio test: (1) the full logistic regression model that included caregiver variables, and (2) a reduced model that included only care-recipient factors.

We conducted a sensitivity analysis using an alternative definition of PIM excluding oral estrogens. The prevalence of non-estrogen PIM use was 31% in dementia patients and 27% in caregivers. While the exclusion of estrogens reduced the overall prevalence of PIM use, a reduction primarily noted in caregivers, the unadjusted and adjusted results were not altered substantively (available upon request). All reported results are based on the original definition of PIM use with estrogens included in the definition.

## RESULTS

### Description of Sample

Table 1 profiles characteristics of caregiver and care-recipients in the sample. Mean caregiver age was 74.2 years (Standard Deviation [SD] = 6.0), and mean care-recipient age was 79.5 years (SD = 6.6). 85% of caregivers were the care-recipient's spouse. Sixty-seven percent of caregivers were white, 17% were black, and 16% were Hispanic. Care-recipients were taking an average of 5.4 medications (SD = 3.0; Range:0-19). A total of 187 care-recipients (33%) were taking  $\geq 1$  PIM. On average, caregivers were taking 4.4 medications (SD = 3.0; Range: 0-15). Over 39% of caregivers (n=223) were taking at  $\geq 1$  PIM.

Table 1 also displays the bivariable analysis of care-recipient PIM use by independent variables. Of the care-recipients taking  $\geq 1$  PIM, 90% had a spouse caregiver, and among care-recipients with no PIM use, 82% had a spouse caregiver ( $\chi^2$ ,  $p = .01$ ). Care-recipients on  $\geq 1$  PIM were taking more medications overall (6.9 vs. 4.6,  $p < .001$ ). Caregivers of care-recipients on  $\geq 1$  PIM were also taking more medications overall (5.1 vs. 4.0,  $p < .001$ ), and were more likely to be on  $\geq 1$  PIM (47.1% vs. 35.6%,  $p = .01$ ).

The most commonly used PIM classes in dementia care-recipients (Table 2) were antihistamines with anticholinergic effects (11.8% of all PIMs), oral estrogens (11.6%), muscle relaxants and antispasmodics (9.4%), fluoxetine (8.0%), and short-acting nifedipine (6.6%). The 10 most common PIM classes in care-recipients accounted for over 70% of all PIMs. The most commonly used PIM classes in caregivers were oral estrogens (34.9%), non-steroidal anti-inflammatories (8.6%), long-acting benzodiazepines (6.2%), fluoxetine (5.5%), and short-acting nifedipine (5.1%). The 10 most common PIM classes in caregivers accounted for about 82% of all PIMs.

### Factors Predicting Potentially Inappropriate Medication Use in Dementia

**Patients Caregiver Factors**—The overall significance of caregiver factors in predicting care-recipient PIM use was evaluated using a Likelihood Ratio test (LRT) and revealed that inclusion of caregiver factors significantly improved model fit ( $LRT_{full} - LRT_{reduced} = 29.9$ ;  $p < .001$ ) and were, as a group, significantly associated with care-recipient PIM use.

Table 3 contains unadjusted and adjusted logistic regression results for each independent variable, and Table 4 presents discrete changes in adjusted predicted probabilities for the multivariable logistic regression model. Caregiver PIM use was significantly associated with care-recipient PIM use in both unadjusted (OR, 1.61, 95% CI, 1.20 – 2.16) and adjusted models (1.59; 95% CI, 1.12 – 2.25) models; an increase in prevalence of care-recipient PIM use of 9.9 percentage points when caregivers were on  $\geq 1$  PIM (Table 4).

A number of other caregiver factors were also significantly associated with care-recipient PIM use. Increased caregiver age was associated with a *decreased* likelihood of PIM use by the care-recipient (OR, 0.93, 95% CI, 0.88 – 0.98). The following caregiver factors were associated with an *increased* likelihood of care-recipient PIM use: spouse versus other relationship to the caregiver (OR, 5.13; 95% CI, 2.10 – 12.53); Hispanic versus white race/ethnicity (OR, 2.60; 95% CI, 1.04 – 6.52); and number of years living in the United States (OR, 1.03; 95% CI, 1.00 – 1.05).

**Care-recipient Factors**—The total number of medications currently being taken by the care-recipient was significantly associated with their own PIM use (Table 3). Care-recipients taking 4-8 medications versus 0-3 medications were significantly more likely to be on a PIM (OR, 3.30; 95% CI, 2.17 – 5.03), as were care-recipients taking 9 or more medications (OR, 7.60; 95% CI, 4.57 – 12.62); an increase in the predicted probability of care-recipient PIM

use of 21.1 percentage points for those taking 4-8 medications and 41.5 points for those taking 9 or more (Table 4).

The only other care-recipient factor associated with PIM use was care-recipient sex. Specifically, male care-recipients were significantly less likely to be on a PIM compared to female care-recipients (OR, 0.48; 95% CI, 0.30 – 0.79). Post hoc analysis (not presented in Tables) revealed this gender difference was driven largely by oral estrogen use in female care-recipients (estrogens excluded: OR, 0.80; NS).

## DISCUSSION

Our study documents the prevalence of potentially inappropriate medication (PIM) use in non-institutionalized dementia patients and their informal caregivers, and explores a range of caregiver and patient risk factors for PIM use in dementia patients. We found that PIM use was common in both dementia patients and caregivers. By applying an explicit criteria for identifying PIMs to both prescription and over-the-counter (OTC) medications, we found that 33% of dementia patients were currently taking at least one PIM. We also found the PIM prevalence in elder informal caregivers was 39%.

Consistent with access and utilization of other health services by dementia patients,<sup>11-13</sup> we found that caregiver factors were significantly associated with PIM use in dementia patients. Although this finding has not been previously reported in the literature, it is not surprising since informal caregivers often serve as surrogates for medical decision making among patients with dementia.<sup>30</sup> Interestingly, we found that caregiver PIM use was associated with risk of PIM in the care-recipient. Consistent with a body of research demonstrating high concordance of health status and health behaviors within families,<sup>31</sup> there are several possible explanations for this intriguing finding. One possible explanation is that caregivers and patients within the same dyad share the same resources, including the social network members, physical environment, and health care providers.<sup>32</sup> In particular, if caregivers and care recipients are utilizing the same health system and or specific providers, they will likely be subject to the same prescribing preferences of these health systems and providers.<sup>33</sup> The fact that patient PIM risk was particularly high when being cared for by a spouse (versus other family member) lends support to this possible explanation. Another possibility is that caregivers on a PIM for a specific condition (e.g, diphenhydramine for sleep, naproxen for pain, fluoxetine for depression) may be primed to recognize similar symptoms in the care-recipient and seek similar prescription or over-the-counter therapies. The fact that specific physical and mental health conditions have been shown to cluster within couples is consistent with this explanation.<sup>31</sup> Finally, prior research suggests that 23% of patients have loaned their medications, and 27% admit to having borrowed medications.<sup>34</sup> Therefore, it is also possible that dyad members were sharing prescription and/or OTC medications. Ultimately, the underlying reasons for the identified association will likely depend on the source of the PIM (prescription or OTC) for caregivers and patients; something we cannot determine from the current data that signals an area for needed research.

Our estimate of PIM use of 33% of dementia patients is considerably higher than previous estimates from non-institutionalized populations with dementia,<sup>35-37</sup> and caregiver PIM use was also higher than estimates from the overall non-institutionalized older adult population.<sup>2,4,38</sup> Prior research in dementia patients has either limited PIMs to those medications known to exacerbate cognitive impairment,<sup>37,39</sup> or relied exclusively on prescription medication data to calculate PIM rates in dementia patients.<sup>35,36</sup> However, older adults are the largest group of purchasers of OTC medications,<sup>40</sup> and a number of medications on the Beers list are available OTC without a prescription. For example, the most common class of PIMs used by dementia patients in our sample was diphenhydramine.

This finding is particularly concerning because antihistamines with strong anticholinergic properties such as diphenhydramine are known to increase the risk of cognitive impairment and falls in older adults,<sup>18</sup> and may work antagonistically to acetylcholinesterase inhibitors (donepezil, galantamine, rivastigmine). Furthermore, the risk of OTC antihistamine use as a sleep aid -- often labeled as “PM” on the drug packaging -- may be particularly high in this population given the high prevalence of sleep disturbance in persons with dementia and their informal caregivers.<sup>41,42</sup> Unfortunately, despite these risks, the use of non-prescription PIMs may go undetected in dementia patients because healthcare providers tend to underestimate overall OTC medication use in their patients.<sup>43</sup>

The inclusion of OTC medications may also explain the particularly high prevalence of PIM use in dementia patients being cared for by Hispanic caregivers in our sample, a finding that is inconsistent with prior research reporting lower rates of inappropriate prescription medication use in racial/ethnic minorities.<sup>44</sup> There is a long tradition of self-diagnosis, self-care and home remedy use in Hispanic communities,<sup>45</sup> and it is possible that Hispanic caregivers are more likely to rely on non-prescription remedies or nonmedical sources for prescription medications (eg, family members in the United States or in their countries of origin, local *tiendas* [grocers]).<sup>46</sup> It is also interesting that the longer the caregiver and patient have lived in the United States, the more likely they were to be PIM users. In the case of inappropriate prescribing, greater access and utilization of prescription medications is perhaps the single strongest risk factor for PIM exposure.<sup>2,4</sup> Although counterintuitive, this finding may actually be a negative consequence of increased access to care in immigrants the longer they reside in the United States.<sup>47</sup> Further study is needed, however, to more thoroughly explore the nature of these identified disparities.

Taken together, these findings have important clinical implications for dementia patients and their caregivers. First, caregiver and dementia patients may share similar and related patterns of medication use (both good and bad), suggesting that interventions designed to increase medication appropriateness may be more effective if both members of the dyad are jointly targeted for medication therapy management. Second, the high prevalence of PIM use found in our sample suggests that healthcare providers should routinely screen for PIM use by reviewing both OTC and prescription medications. Validated tools such as the Screening Tool of Older Persons' potentially inappropriate Prescriptions (STOPP) can be implemented to detect PIM use and potentially reduce adverse drug events in older adults.<sup>48</sup> The integration of pharmacists into the patient-centered medical home has also shown promise in reducing PIM prescribing by physicians and increasing patient adherence to medication regimens.<sup>49-51</sup> Furthermore, with their access to patient's medication history, and with the widespread availability of OTC medications in pharmacies, the community pharmacist may be uniquely situated in the healthcare system to evaluate and counsel older adults on appropriate OTC and prescription medication use.

There are a number of limitations to this study that should be acknowledged. First, the REACH sample was limited to older family caregivers of moderate to severe dementia patients, and results of our study may not be generalizable to earlier-stages of dementia or other community-dwelling caregiving dyads (**including dyads with younger caregivers**). Second, while the inclusion of OTC medications is a main strength of our study, we are unable to separate OTC from prescription medications in our data. Therefore, we cannot determine the proportion of PIMs attributable to prescribers versus self-treatment using OTC products. This is an important area for future research as interventions designed to reduce prescription PIM use will likely differ from interventions designed to reduce OTC PIM use. Third, without information about drug dosages or specific patient diseases we were only able to analyze a partial list of Beers medications. Therefore, we are likely underestimating the true prevalence of PIM use. Fourth, REACH data was collected in 1996-2001 and may

differ from current prescribing and OTC utilization patterns. However, analyses of more recent medication data indicates that several of the most commonly used PNIMs in 1996-2001 continue to be used frequently by older adults today.<sup>52</sup> Finally, the list of PIM medications was recently updated by a panel of experts. While many of the original PIMs remain on the updated list, it is possible our results may change using the updated list of PIMs.<sup>53</sup>

## Conclusions

This study uses an explicit criteria to document the magnitude of potentially inappropriate medication (PIM) use in a sample of dementia patients and their primary family caregivers, and identifies potential caregiver risk factors for patient PIM use. Our findings suggest that the risk of PIM use in dementia patients (and caregivers) may be higher than previously reported and highlight the potential importance of recognizing OTC medications when assessing PIM use. In addition, the identified associations between caregiver factors and care-recipient PIM use, including caregivers' own use of PIMs, suggests that interventions to increase appropriate medication use in dementia patients and/or caregivers may be more effective if both members of the dyad are targeted.

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### CONFLICT OF INTEREST

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**Table 1**

Characteristics of Elder Caregivers and Dementia Patients, Overall and by Care-recipient Potentially Inappropriate Medication Use (n=566)

Study Variables	Overall Sample	Care-Recipient PIM Use (n=187)	No Care-Recipient PIM Use (n=379)	Difference: P-value
<b>Predisposing characteristics</b>				
<b>Caregiver</b>				
Age, mean (SD)	74.2 (6.0)	74.2 (6.1)	74.2 (6.0)	0.98
Relationship to care-recipient, no. (%)				0.01
Spouse	479 (84.6)	169 (90.4)	310 (81.8)	
Other relationship	87 (15.4)	18 (9.6)	69 (18.2)	
Education, no. (%)				0.65
Less than high school degree	134 (23.7)	48 (25.7)	86 (22.7)	
High school degree only	150 (26.5)	46 (24.6)	104 (27.4)	
Some college	282 (49.8)	93 (49.7)	189 (49.9)	
Race/ethnicity, no. (%)				0.81
White non-Hispanic	380 (67.1)	128 (68.5)	252 (66.5)	
Black non-Hispanic	96 (17.0)	29 (15.5)	67 (17.7)	
Hispanic	90 (15.8)	30 (16.0)	60 (15.8)	
<b>Care-recipient</b>				
Age, mean (SD), y	79.5 (6.6)	79.1 (6.2)	79.6 (6.8)	0.32
Sex, no. (%)				0.59
Male	345 (61.0)	111 (59.4)	234 (61.7)	
Female	221 (39.1)	76 (40.6)	145 (38.3)	
<b>Enabling characteristics</b>				
Caregiver perceived financial inadequacy, mean (SD)	2.0 (1.0)	2.0 (1.0)	2.0 (1.0)	0.71
Household Income, no. (%)				0.53
<\$20,000	222 (39.2)	68 (36.4)	154 (40.6)	
\$20,000-39,999	218 (38.5)	73 (39.0)	145 (38.3)	
\$40,000	126 (22.3)	46 (24.6)	80 (21.1)	
Caregiver employment status, no. (%)				0.32
Works full or part-time	52 (9.2)	14 (7.5)	38 (10.0)	
Not working	514 (90.8)	173 (92.5)	341 (90.0)	
Years caregiver has lived in United States, mean (SD)	66.5 (16.6)	67.4 (16.6)	66.1 (16.6)	0.39
Caregiver depressive symptoms (CES-D), mean (SD)	18.2 (11.1)	18.4 (10.8)	18.1 (11.3)	0.74
Caregiver number of chronic conditions, mean (SD)	1.7 (1.2)	1.8 (1.2)	1.7 (1.2)	0.13
Caregiver perceived health, no. (%)				
Perceived health is fair/poor	240 (42.4)	85 (45.6)	155 (40.9)	0.30
Perceived health is good/very good/excellent	326 (57.6)	102 (54.6)	224 (59.1)	
<b>Need characteristics – Care-recipient</b>				
Count of ADL and IADL limitations, mean (SD)	10.2 (3.1)	10.0 (3.2)	10.3 (3.0)	0.35
Mini-mental State Examination, mean (SD)	12.9 (7.7)	13.9 (7.7)	12.4 (7.7)	0.03

Study Variables	Overall Sample	Care-Recipient PIM Use (n=187)	No Care-Recipient PIM Use (n=379)	Difference: P-value
Revised Memory/Behavior checklist, mean (SD)	9.8 (3.8)	10.1 (3.8)	9.7 (3.8)	0.26
<b>Medication Use in Past Month</b>				
<b>Care-recipient medication use</b>				
Total number of medications, mean (SD)	5.4 (3.3)	6.9 (3.4)	4.6 (3.0)	<.001
Distribution of total medications, no. (%)				<.001
0-3 medications	178 (31.5)	27 (14.4)	151 (39.8)	
4-8 medications	295 (52.1)	106 (56.7)	189 (49.9)	
9 or more medications	93 (16.4)	54 (28.9)	39 (10.3)	
<b>Care-recipient PIM use, no. (%)</b>				N/A
No PIM	379 (67.0)	N/A	N/A	
1 PIM	187 (33.0)	N/A	N/A	
<b>Caregiver medication use</b>				
Total number of medications, mean (SD)	4.4 (2.98)	5.1 (3.1)	4.0 (2.9)	<.001
Distribution of total medications, no. (%)				<.001
0-3 medications	243 (42.9)	62 (33.2)	181 (47.8)	
4-8 medications	271 (47.9)	99 (52.9)	172 (45.4)	
9 or more medications	52 (9.2)	26 (13.9)	26 (6.9)	
<b>Caregiver PIM use, no. (%)</b>				
No PIM	343 (60.6)	99 (52.9)	244 (64.4)	0.01
1 PIM	223 (39.4)	88 (47.1)	135 (35.6)	

PIM, Potentially Inappropriate Medication ; SD, standard deviation; CG, Caregiver; ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living; N/A, Not Applicable

**Table 2**

Top 10 Potentially Inappropriate Medications in Community-Dwelling Elder Dementia Patients and Their Primary Informal Caregiver (n=566)

PIM drug/class	% of all Beers medications	Most common examples in drug class
<b>Care-recipient</b>		
1. Antihistamines with anticholinergic effect	11.8	Diphenhydramine
2. Oral estrogens	11.6	
3. Muscle relaxant or antispasmodic	9.4	Oxybutynin
4. Fluoxetine	8.0	
5. Short-acting nifedipine	6.6	
6. Amitriptyline	5.6	
7. NSAIDs	5.6	Naproxen, Piroxicam, Oxaprozin
8. Doxazosin	4.6	
9. Thioridazine	4.0	
10. Ticlopidine	3.8	
<b>Total % of all Beers Medications</b>	<b>70.7</b>	
<b>Caregiver</b>		
1. Oral estrogens	34.9	
2. NSAIDs	8.6	Naproxen, Piroxicam, Oxaprozin
3. Long-acting benzodiazepine	6.2	Diazepam, Clorazepate
4. Fluoxetine	5.5	
5. Short-acting nifedipine	5.1	
6. Muscle relaxant or antispasmodic	4.5	Oxybutynin, Chlorzoxazone, Ditropan
7. GI antispasmodic	4.5	Belladonna, Dicyclomine, Hyoscyamine
8. Clonidine	4.5	
9. Doxazosin	4.1	
10. Amitriptyline	3.8	
<b>Total % of all Beers Medications</b>	<b>81.5</b>	

PIM, Potentially Inappropriate Medication; NSAID, Non-steroidal anti-inflammatory drug ; GI, gastrointestinal

**Table 3**

Unadjusted and Adjusted Odds Ratios of Any Potentially Inappropriate Medication Use for Community-Dwelling Elder Dementia Patients (n=566)

	Unadjusted		Adjusted	
	Odds Ratio	95% CI	Odds Ratio	95% CI
<b>Caregiver medication use</b>				
Number of medications currently taking				
0-3 medications (reference)	1.00		1.00	
4-8 medications	1.68**	1.18, 2.40	1.00	0.78, 1.51
9 or more medications	2.92**	1.89, 4.50	1.42	0.78, 2.58
Caregiver PIM use				
1 PIM (vs. no PPM)	1.61**	1.20, 2.16	1.59*	1.12, 2.25
<b>Care recipient medication use</b>				
Number of medications currently taking				
0-3 medications (reference)	1.00		1.00	
4-8 medications	3.14**	2.05, 4.79	3.30**	2.17, 5.03
9 or more medications	7.74**	4.90, 12.24	7.60**	4.57, 12.62
<b>Predisposing characteristics</b>				
Caregiver				
Age, y	1.00	0.97, 1.03	0.93**	0.88, 0.98
Relationship to care-recipient				
Spouse (vs. other relationship)	2.09**	1.29, 3.39	5.13**	2.10, 12.53
Education				
Less than high school degree	1.26	0.68, 2.35	1.42	0.74, 2.71
High school degree only (reference)	1.00		1.00	
Some college	1.11	0.70, 1.77	1.02	0.60, 1.75
Race/ethnicity				
White non-Hispanic (reference)	1.00		1.00	
Black non-Hispanic	0.85	0.61, 1.19	1.34	0.84, 2.16
Hispanic	0.98	0.70, 1.38	2.60*	1.04, 6.52
Years caregiver has lived in United States	1.00	1.00, 1.01	1.03*	1.00, 1.05
Care recipient				
Age, y	0.99	0.96, 1.10	1.04	0.99, 1.09
Male (vs. female)	0.91	0.61, 1.33	0.48*	0.30, 0.79
<b>Enabling characteristics</b>				
Caregiver perceived financial difficulties	0.97	0.78, 1.19	1.02	0.77, 1.34
Household Income				
<\$20,000	0.77*	0.59, 0.99	0.79	0.49, 1.30
\$20,00-39,999	0.88	0.57, 1.34	0.99	0.54, 1.80

	Unadjusted		Adjusted	
	Odds Ratio	95% CI	Odds Ratio	95% CI
\$40,000 (reference)	1.00		1.00	
Caregiver works (vs. retired/unemployed)	0.73	0.38, 1.39	0.67	0.35, 1.29
Caregiver depressive symptoms (CES-D)	1.00	0.99, 1.02	1.00	0.98, 1.03
Caregiver number of chronic conditions	1.12	0.96, 1.30	1.07	0.83, 1.39
Caregiver perceived health is fair or poor	1.20	0.86, 1.68	0.96	0.64, 1.45
<b>Care-recipient need characteristics</b>				
Count of ADL and IADL limitations	0.97	0.91, 1.03	0.98	0.92, 1.04
Score on Mini-mental State Examination	1.03 <sup>*</sup>	1.00, 1.05	1.00	0.98, 1.03
Score on Revised Memory/Behavior checklist	1.03	0.98, 1.07	1.03	0.97, 1.09

PIM, Potentially Inappropriate Medication; CG, Caregiver; ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living

\*  
p<.05

\*\*  
p<.01



**Table 4**

## Discrete Changes in Predicted Probabilities

	Discrete Change in Predicted Probability of CR PIM use <sup>*</sup>	Bootstrapped 95% CI
<b>Medication use</b>		
<b>Caregiver (CG)</b>		
0 CG PIMs → CG taking 1 PIM	+9.9	0.5, 17.7
<b>Care recipient (CR)</b>		
Number of medications currently taking		
0-3 medications → 4-8 medications	+21.1	12.8, 29.0
0-3 medications → 9+ medications	+41.5	27.0, 53.3
<b>Other factors</b>		
CG age (1 SD increase)	-8.7	-13.9, -2.7
CG relationship to care-recipient		
Non-spouse → Spouse caregiver	+25.9	13.5, 34.6
CG race/ethnicity		
White non-Hispanic → Hispanic	+21.6	-2.4, 50.3 <sup>†</sup>
CG years living in US (1 SD increase)	+11.0	-0.1, 25.5 <sup>†</sup>
CR sex		
Female → Male	-15.6	-26.1, -4.6

PIM, Potentially Inappropriate Medication; CG, Caregiver; CR, Care-recipient; CI, Confidence Interval ; SD, Standard Deviation.

<sup>\*</sup> Discrete change is the change in predicted probability (multiplied by 100) going from 0 to 1 for binary independent variables with all other covariates set to their mean. For continuous variables, discrete change represents the change in predicted probability of care-recipient PIM associated with a 1 standard deviation change at the mean.

<sup>†</sup> While the bootstrapped 95% CI of the discrete change in predicted probability includes the value of zero, the logistic regression model indicated statistical significance (see Table 3).