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# Long-Term Care

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## Potentially Inappropriate Medication Prescriptions among Elderly Nursing Home Residents: Their Scope and Associated Resident and Facility Characteristics

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**Objective.** To estimate the scope of potentially inappropriate medication prescriptions (PIRx) among elderly residents in U.S. nursing homes (NHs), and to examine associated resident and facility characteristics.

**Data Sources.** The 1996 Medical Expenditure Panel Survey Nursing Home Component (MEPS NHC), a survey of a nationally representative sample of NHs and residents.

**Study Design.** The PIRx, defined by Beers's consensus criteria (1991, 1997), was identified using up to a year's worth of NH prescribed medicine data for each resident. The study sample represented 1.6 million NH residents ( $n = 3,372$ ).

**Results.** At a minimum, 50 percent of all residents aged 65 or older, with an NH stay of three months or longer received at least one PIRx in 1996. The most common PIRx involved propoxyphene, diphenhydramine, hydroxyzine, oxybutynin, amitriptyline, cyproheptadine, iron supplements, and ranitidine. Resident factors associated with greater odds of PIRx were Medicaid coverage, no high school diploma, and non-dementia mental disorders. Facility factors were more beds and lower RN-to-resident ratio. Factors associated with lower odds of PIRx were fewer medications, residents with communication problems, and being in an accredited NH. Onsite availability of pharmacists or mental health providers was not related.

**Implications.** With quality of care and patient safety as major public health concerns, effective policies are needed to avoid PIRx occurrences and improve the quality of prescribing among elderly residents in NHs. Additional studies are needed to determine the impact of PIRx on this NH population.

**Key Words.** Quality of prescribing, medication errors, patient safety, long-term care residential setting, MEPS NHC

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With pharmaceuticals being a principal mode of therapy, nursing home (NH) residents, on average, take 5 to 9 different medications daily and over 20 percent use more than 10 medications (Avorn and Gurwitz 1995; Bernabei

et al. 1999). High medication use poses significant risk to elderly residents for adverse drug reactions because their altered physiological drug metabolism heightens their sensitivity to various drug effects. With more comorbidity and greater medication consumption, elderly patients have increased chances of exposure to potentially inappropriate medication (PIRx), such as drug–disease and drug–drug interactions (Gurwitz et al. 2000; Beers et al. 1992).

Even though PIRx is a major policy concern because of its preventability, and implications for patient safety (Hanlon et al. 2000; Stuart and Briesacher 2002), determining which medications are inappropriate for elderly patients is not straightforward, especially in the absence of widely accepted prescribing guidelines for the elderly. Perhaps the most cited criteria are those developed by Beers and colleagues (1991, 1997), who convened panels of multidisciplinary experts to develop consensus guidelines for PIRx that generally should be avoided among elderly patients. Using only a subset of Beers's criteria, earlier studies in selected populations and geographic areas suggested that a substantial proportion of long-term care residents received PIRx (Aparasu and Mort 2000). The lowest rate of PIRx (25 percent) was reported in a study of elderly residents living in board and care facilities (Spore et al. 1997). Other studies reported higher rates of PIRx among Medicaid patients: 33 percent of NH residents in Kentucky and 49 percent of intermediate care facility residents in Louisiana (Gupta, Rappaport, and Bennett 1996; Piercoro, Browning, and Prince 2000). Using his own criteria, Beers found that 40 percent of residents in skilled nursing facilities near Los Angeles had at least one PIRx (Beers et al. 1992).

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Quality of care and patient safety have received renewed attention due to recently published Institute of Medicine reports (Institute of Medicine 2001; Kohn, Corrigan, and Donaldson 1999; Wunderlich and Kohler 2001). This study examines PIRx in the NH setting using both versions of Beers's criteria (1991, 1997), which include three types of PIRx: inappropriate drug choice, excess dosage, and drug–disease interactions. Even though Beers's 1991 criteria were developed for elderly NH residents, and the 1997 criteria for community-dwelling elderly, it is appropriate to use the 1997 criteria to analyze PIRx among NH residents because elderly NH residents generally are more frail and sick, and may be more sensitive to drug effects than their community-dwelling counterparts. Drugs that are identified as PIRx for community-dwelling individuals should pose similar, if not greater, risks of adverse side effects for persons living in NHs.

The present study analyzes data from a nationally representative sample of NHs and residents to determine the scope of PIRx in the United States. Previous studies using national data sources have analyzed PIRx among community-dwelling elderly patients (Zhan et al. 2001), and those receiving care at outpatient departments or physician offices (Aparasu and Fliginger 1997; Goulding 2004; Mort and Aparasu 2000).

In addition to the prevalence, this study investigates the influence of two types of risk factors—resident and facility characteristics—on having PIRx exposure in the nursing home setting. Based on prior studies, we expect that the risk of PIRx exposure will vary across resident characteristics because of differences in *health factors* (mental health, physical limitations, and behavior and communication problems), *the complexity of drug regimens* (number of medications), and *insurance status*. Residents with mental disorders (Schmidt et al. 1998), on greater number of medications (Piercoro, Browning, and Prince 2000; Spore et al. 1997), and on Medicaid (Gupta, Rappaport, and Bennett 1996; Piercoro et al. 2000) have been found to be at higher risk of having PIRx exposure. Because residents are not randomly distributed among nursing homes, it is necessary to control for resident characteristics when examining nursing home characteristics. The variables selected (age, sex, race, marital status, number of living children, education, and poverty status) include both predisposing and enabling characteristics in the conceptual frameworks of healthcare utilization (Andersen 1995). Their role in quality of care is less well understood and they are included here primarily as background variables. Identifying resident characteristics that are associated with PIRx could serve as markers to target quality improvement initiatives, such as care planning and drug regimen reviews.

Furthermore, we are examining facility characteristics that are associated with having PIRx. It is clear that facility-level approaches to quality improvement and patient safety may be among the most effective (Institute of Medicine 2001; Kohn, Corrigan, and Donaldson 1999). We expect that the risk of PIRx will vary across characteristics associated with the *organizational structure* (ownership, size, and type), *nurse staffing levels* (ratio of registered nurses to nonregistered nurses, and ratio of nursing staff to patients), *regulatory indicators* (certification by Medicaid and Medicare, accreditation by the Joint Commission on Accreditation of Healthcare Organizations, and presence of consultant pharmacist onsite), *high-level technological services* (such as ventilator care, intravenous therapy, dialysis, and tube feeding), and *geographical locations* (census region, metropolitan versus rural area, and the income-per-capita of the neighborhood). Facilities that had for-profit ownership (Harrington et al. 2001), a greater number of beds (Beers et al. 1992), poor nurse staffing levels (Harrington et al. 2000; Schmidt et al. 1998), as well as facilities that did not offer high-level technological services and were situated in poorer neighborhoods (Cohen and Spector 1996), were found to be associated with having either PIRx exposure or poor overall quality of patient care. Findings of this study will help us better understand the roles of resident and facility characteristics in PIRx exposure and can help inform the process of developing strategies to improve pharmaceutical services in nursing homes.

## METHODS

### *Study Design and Sample*

Data were from the 1996 Medical Expenditure Panel Survey Nursing Home Component (MEPS NHC), a survey of a nationally representative sample of NHs and residents. The MEPS NHC was primarily designed to provide national estimates of the use and expenditures for NH health services for all users of NHs at any time during 1996. Using a complex multistage study design, the MEPS NHC sampled NHs in the first stage and persons within selected NHs in the second stage. The sample included persons who were residents in NHs on January 1, 1996, as well as those who were admitted to NHs during the year (Potter 1998).

The MEPS NHC data were primarily collected from NH sources. Data on all medications prescribed for residents were obtained from NH medical charts and recorded for each calendar month that a person was a resident in an

NH (including transfer facilities) during the year; however, drug data were not obtained for stays in non-NH facilities, such as acute care wings of hospitals. Information on drug name, form, strength, dosage, and frequency of administration were captured (Potter 1998).

This study included residents, aged 65 or older, who resided in an NH for at least three consecutive months during 1996. The minimum three-month stay allowed residents to have sufficient time to be exposed to the care provided in a given NH. Additional cases were excluded: 20 comatose residents, 5 residents missing all health insurance or drug data, 4 with no drugs administered, and 13 who lived in NHs that served primarily persons with mental illness and those with HIV/AIDS. The final study sample represented 1.6 million residents ( $n = 3,372$ ), or 51 percent of all NH users in 1996.

Analyses used up to 12 months of drug data for each resident. About 23 percent of the study sample had at least one month of missing drug data, but among these, only 7 percent had drug data missing for more than half of the months of their NH stay. Reasons for missing drug data included refusals by the facility to provide information, inability to locate medical charts, and loss to follow-up (Potter, Lau, and Dominici 2002).

### Measures

*Potentially Inappropriate Medication (PIRx)*. Beers's criteria identified three types of PIRx: (1) *inappropriate drug choice*: medications that generally should be avoided among any elderly patients; (2) *excess dosage*: medications at a dose or duration that should not be exceeded for any elderly patients; and (3) *drug-disease interaction*: medications that should be avoided among certain elderly patients with specific comorbid conditions (Beers et al. 1991; Beers 1997). Residents were considered to have a PIRx exposure in a given month if any of the following conditions were met: (1) medication names matched the names of any drugs listed as *inappropriate drug choice* in Beers's criteria; (2) strengths and average dosages of medications matched the strengths and average dosages defined as *excess dosage* in Beers's criteria; or (3) residents had active diagnoses and took medications that matched any of the disease and drug combinations indicated as *drug-disease interaction* in Beers's criteria (Beers et al. 1991; Beers 1997). Residents with any PIRx exposure were those with any of the three types of PIRx exposure in one or more months during their NH stay.

Beers's criteria also included a severity index for each PIRx medication, dosage and drug-disease interaction to indicate whether the exposure had

high or low potential harm to a patient. The index was defined conceptually as the likelihood of an adverse outcome occurring and the clinical significance of that outcome if it occurs (Beers 1997). A measure of PIRx with the potential for severe harm (PIRx-severe) was created based on whether any PIRx matched those listed as PIRx-severe in Beers's criteria.

*Resident and Facility Characteristics.* Resident characteristics were as of January 1, 1996, for current residents, and as of the date of admission for all others. Age, sex, race, marital status, living offspring, education, and poverty status were constructed based on data from NH records and community next-of-kin. Poverty level was constructed from edited items on resident's (and the resident's spouse, if married) gross annual household income using poverty thresholds published by the U.S. Bureau of the Census (Rhoades and Sommers 2000). Admission before 1996 refers to persons who were admitted to an NH before January 1, 1996. Number of NH days, constructed from data reported by NH and community sources, reflected the total days a resident stayed in any NH during 1996 (Potter 2000).

Health status data were obtained from NH medical records. Mental health status was constructed from items on active diagnosis and collapsed into a single variable with three categories: (1) any dementia, including organic brain syndrome, Alzheimer's disease, and related dementia; (2) other mental disorders only, such as anxiety disorder, depression, manic depression, schizophrenia, and mental retardation; and (3) no mental disorders. Functional health status was defined as the number of activities of daily living (ADLs) for which a resident required supervision or assistance. These ADLs included dressing, bathing, eating, transferring from a bed or chair, mobility, and toileting (Rhoades and Sommers 2000). Behavior problems were defined as exhibiting one or more of the following behaviors: verbally abusive, physically abusive, wandering, resisting care, or disruptive. Communication problems were present if a resident was not able to understand others or other people could not understand the resident (Krauss and Altman 1998). A resident's regular drug regimen was defined as the average number of regularly scheduled medications administered per month, excluding "as needed" drugs.

Facility characteristics were based on MEPS survey data collected from NH sources and linked to the residents. For residents in only one NH during the year (about 90 percent of the residents), facility characteristics were associated with that NH. For residents in more than one NH, facility characteristics were associated with the stay of three months or longer. In the

event a resident had more than one NH stay that exceeded three months, if no PIRx occurred, the first stay was selected; otherwise, the stay with PIRx was selected.

Facility type was defined as hospital-based, multilevel care (including those with continuing care retirement communities and personal care units), or NH-beds only. Certification status indicated whether the NH was certified as a Medicare skilled-nursing facility, or Medicaid nursing facility. Accreditation status refers to accreditation by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) (Rhoades, Potter, and Krauss 1998). Both RN-to-non-RN and RN-to-resident ratios included only full-time employees, and not part-time or “pooled” staff. Selected technological services included four services: ventilator care, intravenous therapy, dialysis, and tube feeding. The percentage of residents vaccinated for influenza was estimated by NH respondents.

Census region and Metropolitan Statistical Area (MSA) were defined using the U.S. Bureau of the Census criteria (Rhoades and Sommers 2000). Two county-level characteristics were obtained from the 1998 Area Resource File (ARF): NH bed availability and income per capita. The former was defined by the number of empty NH beds per 1,000 people aged 75 and older; the smaller the value, the fewer NH beds available (Cohen and Spector 1996).

### *Statistical Analysis*

All descriptive analyses and logistic regression analyses were performed using weighted data and *SUDAAN* software to account for the complex design of the MEPS NHC (Shah, Barnwell, and Bieler 1995). Univariate relationships and multivariate regression models were examined to identify resident and facility characteristics that were associated with either (1) any PIRx occurrences or (2) PIRx-severe. Three different specifications of the model were estimated, where the first specification contained only resident characteristics, the second specification contained only facility characteristics, and the final specification contained both resident and facility characteristics. The combined resident-and-facility multivariate models included variables that were statistically significant ( $p < 0.10$ ) in either the model with resident characteristics or the model with facility characteristics. Key resident characteristics—age, sex, race, admission before 1996, and number of NH days in 1996—were kept in the combined model regardless of statistical significance.

## RESULTS

### *Potentially Inappropriate Medication Prescriptions*

Approximately 50 percent of all elderly residents with an NH stay of three months or longer received at least one PIRx in 1996 (Table 1). Among those residents with PIRx, 56 percent involved a single drug, 26 percent involved two different drugs, and 17 percent involved three or more different drugs. (The number refers to the number of different drug names that matched Beers's criteria and not frequency of exposure.) The type of PIRx varied: 40 percent of all NH residents had *inappropriate drug choice*, 11 percent had *excess dosage*, and 13 percent had *drug-disease interaction*. During 1996, PIRx exposure was rarely a single event. When PIRx occurred, a third of the residents (35 percent) had a PIRx for almost their entire NH stay (months with PIRx/months in NHs  $\geq 90$  percent). Among those residents living in the NH for the full year, more than one in five residents received a PIRx for every month of the entire year.

Among residents with any PIRx, one in three (34 percent) had a PIRx with the potential for severe harm (PIRx-severe). Most (84 percent) were due to *inappropriate drug choice*. Among those receiving a PIRx-severe, 81 percent involved a single drug, and 19 percent involved two or more different drugs. (Data are not shown in the table.)<sup>1</sup>

Therapeutic classes most frequently involved in PIRx included narcotics, antihistamines with strong anticholinergic effects, sedatives/hypnotics, gastrointestinal/antispasmodic agents, antidepressants, platelet inhibitors, and iron supplements. The most common *inappropriate drug choices* involved propoxyphene, diphenhydramine, hydroxyzine, oxybutynin, amitriptyline, and cyproheptadine. The most prevalent *excess dosage* occurred with iron supplement (more than 325 mg daily) and ranitidine (over 300 mg for longer than 12 weeks). The most frequent *drug-disease interactions* occurred among residents with chronic obstructive pulmonary disease taking sedatives/hypnotics, and residents with constipation taking anticholinergic agents. (Data are not shown in the table.)<sup>2</sup>

### *Resident and Facility Characteristics*

Elderly NH residents with stays of three months or longer were predominantly over 85 years of age, female, white, not married, and had living children (Table 2). The majority were admitted before 1996, and resided in an NH in 1996 for at least nine months. More than half of the residents had dementia or some other mental disorders. Over one-quarter had behavior problems and



Table 1: Patterns of Potentially Inappropriate Medication Prescriptions (PIRx) among Residents, Aged 65 and Older, with a Nursing Home Stay of Three Consecutive Months or Longer in 1996.<sup>§</sup>

| <i>Patterns of PIRx</i>                        | <i>% of Residents (S.E.)</i> |
|--|------------------------------|
| <i>Number of PIRx<sup>¶</sup></i>              |                              |
| Zero (no PIRx)                                 | 49.7 (1.04)                  |
| At least one                                   | 50.3 (1.04)                  |
| One  | 28.1 (0.86)                  |
| Two  | 13.3 (0.73)                  |
| Three  | 5.3 (0.40)                   |
| Four or more                                   | 3.6 (0.33)                   |
| <i>Type of PIRx<sup>#</sup></i>                |                              |
| Inappropriate drug choice                      | 40.4 (1.04)                  |
| Excess dosage                                  | 11.4 (0.61)                  |
| Drug-disease interaction                       | 12.8 (0.64)                  |
| <i>PIRx with the potential for severe harm</i> | 17.3 (0.81)                  |

<sup>§</sup>51% of all nursing home users in 1996 ( $n = 3,372$ ). Percentages based on weighted data and available prescribed medicine data.

<sup>¶</sup>Number of PIRx indicates the number of different drugs names that matched Beers's criteria received during the year and not the frequency of use.

<sup>#</sup>Residents can have multiple types of PIRx exposures during the year.

*Source:* Center for Cost and Financing Studies, Agency for Healthcare Research and Quality, The 1996 Medical Expenditure Panel Survey Nursing Home Component.

close to one-third had communication problems. Close to half required supervision or assistance in all six ADLs, and a quarter averaged nine or more medications monthly.

The majority of residents were in for-profit NHs, and dually certified facilities; most were in nonaccredited NHs. More than one-third were in NHs with fewer than 1 RN to every 10 non-RNs, and one-quarter were in NHs with fewer than 1 RN to every 20 residents. Most also were in NHs that provided fewer than three of four technological services—intravenous therapy and tube-feeding were most commonly available.

Resident and facility characteristics were evaluated in separate models (Table 2). To assess the correlations among independent variables, multicollinearity tests were performed. RN-to-non-RN ratio was dropped from the facility model due to its correlation with RN-to-resident ratio (correlation coefficient = 0.86; variance inflation factor = 3.92). Variable selection for the multivariate model was based on significance ( $p < 0.10$ ) in these models. In all, 11 resident characteristics (age, sex, race, Medicaid coverage, admission before 1996, number of NH days, mental and functional status, communication and behavior problems, and number of medications), and 5 facility

Table 2: Characteristics of Nursing Home Residents and Multivariate Logistic Regression Analysis of Resident and Resident/Facility Characteristics Associated with Having Potentially Inappropriate Medication Prescriptions (PIRx).<sup>§</sup>

| Characteristics                        | % of Residents | Resident Model |               | Facility Model |          | Resident/Facility Model |                           |
|--|----------------|----------------|---------------|----------------|----------|-------------------------|---------------------------|
|  |                | Odds Ratio     | 95% C.I.      | Odds Ratio     | 95% C.I. | Odds Ratio              | 95% C.I.                  |
| <b>Resident Characteristics</b>        |                |                |               |                |          |                         |                           |
| <i>Age</i>                             |                |                |               |                |          |                         |                           |
| 65-74                                  | 14.6           | 1.00           | (0.81, 1.34)  |                |          | 1.07                    | (0.83, 1.38)              |
| 75-84                                  | 35.8           | 1.04           | (0.74, 1.06)  |                |          | 0.93                    | (0.78, 1.11)              |
| 85 and older                           | 49.6           | 0.89           | (1.00, 1.00)  |                |          | 1.00                    | (1.00, 1.00)              |
| <i>Sex</i>                             |                |                |               |                |          |                         |                           |
| Male                                   | 26.2           | 1.16           | (0.96, 1.40)  |                |          | 1.14                    | (0.95, 1.37)              |
| Female                                 | 73.8           | 1.00           | (1.00, 1.00)  |                |          | 1.00                    | (1.00, 1.00)              |
| <i>Race</i>                            |                |                |               |                |          |                         |                           |
| Black                                  | 8.1            | 0.79           | (0.60, 1.05)  |                |          | 0.78                    | (0.59, 1.04) <sup>†</sup> |
| White/Hispanics/others                 | 91.9           | 1.00           | (1.00, 1.00)  |                |          | 1.00                    | (1.00, 1.00)              |
| <i>Marital status</i>                  |                |                |               |                |          |                         |                           |
| Married                                | 17.9           | 1.10           | (0.87, 1.38)  |                |          |                         |                           |
| Not married                            | 82.1           | 1.00           | (1.00, 1.00)  |                |          |                         |                           |
| <i>Living children</i>                 |                |                |               |                |          |                         |                           |
| Yes                                    | 70.6           | 1.02           | (0.86, 1.22)  |                |          |                         |                           |
| No                                     | 29.4           | 1.00           | (1.00, 1.00)  |                |          |                         |                           |
| <i>Education level</i>                 |                |                |               |                |          |                         |                           |
| No high school degree                  | 54.6           | 1.02           | (0.85, 1.22)  |                |          |                         |                           |
| With high school degree                | 45.4           | 1.00           | (1.00, 1.00)  |                |          |                         |                           |
| <i>Poverty level</i>                   |                |                |               |                |          |                         |                           |
| Less than poverty                      | 26.2           | 1.06           | (0.71, 1.57)  |                |          |                         |                           |
| 100 to <200 percent                    | 45.6           | 0.88           | (0.61, 1.27)  |                |          |                         |                           |
| 200 to <400 percent                    | 20.9           | 0.89           | (0.60, 1.31)  |                |          |                         |                           |
| 400 percent or more                    | 7.3            | 1.00           | (1.00, 1.00)  |                |          |                         |                           |
| <i>Medicaid coverage</i>               |                |                |               |                |          |                         |                           |
| Yes                                    | 71.3           | 1.39           | (1.10, 1.75)* |                |          | 1.31                    | (1.09, 1.59)*             |
| No                                     | 28.7           | 1.00           | (1.00, 1.00)  |                |          | 1.00                    | (1.00, 1.00)              |
| <i>Admission before 1996</i>           |                |                |               |                |          |                         |                           |
| Yes                                    | 77.5           | 1.06           | (0.82, 1.39)  |                |          | 0.99                    | (0.79, 1.24)              |
| No                                     | 22.5           | 1.00           | (1.00, 1.00)  |                |          | 1.00                    | (1.00, 1.00)              |
| <i>Nursing home days in 1996</i>       |                |                |               |                |          |                         |                           |
| 90 to 120 days                         | 4.9            | 0.87           | (0.56, 1.34)  |                |          | 0.84                    | (0.56, 1.25)              |
| 121 to 200 days                        | 11.4           | 0.87           | (0.64, 1.17)  |                |          | 0.86                    | (0.65, 1.13)              |
| 201 to 280 days                        | 11.6           | 1.04           | (0.75, 1.43)  |                |          | 0.98                    | (0.74, 1.31)              |
| 281 to 366 days                        | 72.1           | 1.00           | (1.00, 1.00)  |                |          | 1.00                    | (1.00, 1.00)              |
| <i>Mental status</i>                   |                |                |               |                |          |                         |                           |
| Alzheimer's disease and other dementia | 47.7           | 0.88           | (0.72, 1.06)  |                |          | 0.86                    | (0.71, 1.03)              |
| Other mental disorders only            | 15.1           | 1.35           | (1.04, 1.76)* |                |          | 1.40                    | (1.07, 1.82)*             |
| No mental disorder                     | 37.2           | 1.00           | (1.00, 1.00)  |                |          | 1.00                    | (1.00, 1.00)              |

continued

Table 2. Continued

| Characteristics   | % of Residents | Resident Model |                           | Facility Model |                           | Resident/Facility Model |                           |
|---|----------------|----------------|---------------------------|----------------|---------------------------|-------------------------|---------------------------|
|   |                | Odds Ratio     | 95% C.I.                  | Odds Ratio     | 95% C.I.                  | Odds Ratio              | 95% C.I.                  |
| <i>Number of activities-of-daily-living limitations</i> |                |                |                           |                |                           |                         |                           |
| 0 to 3  | 23.5           | 1.05           | (0.84, 1.32)              |                |                           | 1.07                    | (0.85, 1.35)              |
| 4 to 5  | 30.3           | 1.14           | (0.99, 1.40) <sup>†</sup> |                |                           | 1.23                    | (1.01, 1.49)*             |
| 6   | 46.2           | 1.00           | (1.00, 1.00)              |                |                           | 1.00                    | (1.00, 1.00)              |
| <i>Behavior problems</i>                                |                |                |                           |                |                           |                         |                           |
| Yes   | 27.7           | 1.16           | (0.98, 1.39) <sup>†</sup> |                |                           | 1.17                    | (0.98, 1.41) <sup>†</sup> |
| No  | 72.3           | 1.00           | (1.00, 1.00)              |                |                           | 1.00                    | (1.00, 1.00)              |
| <i>Communication problems</i>                           |                |                |                           |                |                           |                         |                           |
| Yes   | 29.7           | 0.66           | (0.55, 0.80)**            |                |                           | 0.69                    | (0.57, 0.84)**            |
| No  | 70.3           | 1.00           | (1.00, 1.00)              |                |                           | 1.00                    | (1.00, 1.00)              |
| <i>Average number of drugs per month</i>                |                |                |                           |                |                           |                         |                           |
| Less than 5   | 31.6           | 0.25           | (0.19, 0.31)**            |                |                           | 0.23                    | (0.19, 0.29)**            |
| 5 to <9   | 44.4           | 0.49           | (0.39, 0.62)**            |                |                           | 0.46                    | (0.37, 0.56)**            |
| 9 or more   | 24.0           | 1.00           | (1.00, 1.00)              |                |                           | 1.00                    | (1.00, 1.00)              |
| Facility Characteristics                                |                |                |                           |                |                           |                         |                           |
| <i>Ownership</i>  |                |                |                           |                |                           |                         |                           |
| For-profit  | 64.6           |                |                           | 1.04           | (0.86, 1.25)              |                         |                           |
| Nonprofit/Public  | 35.4           |                |                           | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Type</i>   |                |                |                           |                |                           |                         |                           |
| Hospital-based  | 7.0            |                |                           | 0.86           | (0.55, 1.35)              |                         |                           |
| With multiple levels of care                            | 12.6           |                |                           | 0.94           | (0.75, 1.19)              |                         |                           |
| With only NH beds                                       | 80.4           |                |                           | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Certification status</i>                             |                |                |                           |                |                           |                         |                           |
| Not federally certified                                 | 3.3            |                |                           | 2.54           | (0.34, 18.89)             |                         |                           |
| Either Medicare only or Medicaid only                   | 16.2           |                |                           | 0.88           | (0.69, 1.14)              |                         |                           |
| Medicare and Medicaid                                   | 80.5           |                |                           | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Accreditation status</i>                             |                |                |                           |                |                           |                         |                           |
| Yes   | 16.6           |                |                           | 0.78           | (0.61, 0.99)*             | 0.70                    | (0.54, 0.92)*             |
| No  | 83.4           |                |                           | 1.00           | (1.00, 1.00)              | 1.00                    | (1.00, 1.00)              |
| <i>Number of beds</i>                                   |                |                |                           |                |                           |                         |                           |
| 3 to 49   | 6.0            |                |                           | 0.66           | (0.41, 1.05) <sup>†</sup> | 0.55                    | (0.34, 0.90)*             |
| 50 to 99  | 25.1           |                |                           | 0.88           | (0.68, 1.13)              | 0.80                    | (0.62, 1.03) <sup>†</sup> |
| 100 to 149  | 33.9           |                |                           | 0.93           | (0.73, 1.18)              | 0.92                    | (0.73, 1.17)              |
| 150 to 199  | 15.7           |                |                           | 1.03           | (0.78, 1.37)              | 0.99                    | (0.74, 1.31)              |
| 200 or more   | 19.3           |                |                           | 1.00           | (1.00, 1.00)              | 1.00                    | (1.00, 1.00)              |
| <i>Registered nurse (RN)-to-non-RN ratio</i>            |                |                |                           |                |                           |                         |                           |
| Fewer than 1 : 10                                       | 32.6           |                |                           |                |                           |                         |                           |
| Between 1 : 10 and 1 : 5                                | 38.5           |                |                           |                |                           |                         |                           |
| Greater than 1 : 5                                      | 28.9           |                |                           |                |                           |                         |                           |
| <i>Registered nurse (RN)-to-resident ratio</i>          |                |                |                           |                |                           |                         |                           |
| Fewer than 1 : 20                                       | 26.0           |                |                           | 1.37           | (1.06, 1.75)*             | 1.41                    | (1.11, 1.78)*             |
| Between 1 : 20 and 1 : 10                               | 42.8           |                |                           | 1.09           | (0.90, 1.31)              | 1.11                    | (0.92, 1.35)              |

continued

Table 2. Continued

| Characteristics  | % of Residents | Resident Model |          | Facility Model |                           | Resident/Facility Model |                           |
|--|----------------|----------------|----------|----------------|---------------------------|-------------------------|---------------------------|
|  |                | Odds Ratio     | 95% C.I. | Odds Ratio     | 95% C.I.                  | Odds Ratio              | 95% C.I.                  |
| Greater than 1 : 10  | 31.2           |                |          | 1.00           | (1.00, 1.00)              | 1.00                    | (1.00, 1.00)              |
| <i>Pharmacist onsite once a week</i>                       |                |                |          |                |                           |                         |                           |
| Yes  | 46.2           |                |          | 0.96           | (0.81, 1.14)              |                         |                           |
| No   | 53.8           |                |          | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Psychologist or psychiatrist onsite once a week</i>     |                |                |          |                |                           |                         |                           |
| Yes  | 41.3           |                |          | 0.97           | (0.81, 1.15)              |                         |                           |
| No   | 58.7           |                |          | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Selected technological services offered<sup>§</sup></i> |                |                |          |                |                           |                         |                           |
| 3 or 4 services  | 13.7           |                |          | 0.95           | (0.72, 1.25)              |                         |                           |
| 2 services   | 44.4           |                |          | 1.08           | (0.81, 1.44)              |                         |                           |
| 1 service  | 32.5           |                |          | 0.95           | (0.67, 1.34)              |                         |                           |
| None   | 9.4            |                |          | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Influenza vaccination percentage</i>                    |                |                |          |                |                           |                         |                           |
| 90 percent and higher                                      | 51.5           |                |          | 1.19           | (0.97, 1.46)              |                         |                           |
| 75 percent to <90 percent                                  | 27.4           |                |          | 1.18           | (0.95, 1.48)              |                         |                           |
| Less than 75 percent                                       | 21.1           |                |          | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Census region</i>                                       |                |                |          |                |                           |                         |                           |
| Northeast  | 23.4           |                |          | 1.20           | (0.88, 1.63)              |                         |                           |
| Midwest  | 31.8           |                |          | 1.23           | (0.92, 1.64)              |                         |                           |
| South  | 32.8           |                |          | 1.18           | (0.88, 1.57)              |                         |                           |
| West   | 12.0           |                |          | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>Metropolitan statistical area</i>                       |                |                |          |                |                           |                         |                           |
| Yes  | 70.1           |                |          | 0.77           | (0.62, 0.96)*             | 0.81                    | (0.65, 1.01) <sup>‡</sup> |
| No   | 29.9           |                |          | 1.00           | (1.00, 1.00)              | 1.00                    | (1.00, 1.00)              |
| <i>Nursing home beds available<sup>#</sup></i>             |                |                |          |                |                           |                         |                           |
| 5 and fewer  | 15.2           |                |          | 0.85           | (0.65, 1.11)              |                         |                           |
| > 5 to 10  | 25.5           |                |          | 1.03           | (0.81, 1.32)              |                         |                           |
| > 10 to 15   | 22.9           |                |          | 1.05           | (0.83, 1.33)              |                         |                           |
| > 15 to 20   | 12.5           |                |          | 1.06           | (0.81, 1.38)              |                         |                           |
| More than 20   | 23.9           |                |          | 1.00           | (1.00, 1.00)              |                         |                           |
| <i>County-level income per capita (in \$1,000s)</i>        |                |                |          |                |                           |                         |                           |
| Less than or equal 20                                      | 30.2           |                |          | 1.27           | (0.90, 1.80)              | 1.31                    | (0.91, 1.87)              |
| >20 to 25  | 34.8           |                |          | 1.33           | (0.98, 1.79) <sup>‡</sup> | 1.35                    | (0.99, 1.85) <sup>‡</sup> |
| >25 to 30  | 23.5           |                |          | 1.51           | (1.11, 2.05)*             | 1.49                    | (1.09, 2.05)*             |
| More than 30   | 11.5           |                |          | 1.00           | (1.00, 1.00)              | 1.00                    | (1.00, 1.00)              |

<sup>§</sup>51% of all nursing home users in 1996 ( $n = 3,372$ ). Percentages based on weighted data.

<sup>¶</sup>Services include ventilator care, intravenous therapy, dialysis, and tube feeding.

<sup>#</sup>Nursing home beds available is the number of empty beds/1,000 elderly (75+ age).

<sup>‡</sup> $p < 0.100$ ;

\* $p < 0.050$ ;

\*\* $p < 0.001$ .

Source: Center for Cost and Financing Studies, Agency for Healthcare Research and Quality, The National 1996 Medical Expenditure Panel Survey Nursing Home Component.

characteristics (accreditation, number of beds, RN-to-resident ratio, MSA, and county-level income per capita) were included in the combined model.

Resident characteristics associated with PIRx ( $p < 0.05$ ) were Medicaid coverage, mental status, communication problems, and number of drugs per month (Table 2). Facility characteristics associated with PIRx ( $p < 0.05$ ) were JCAHO accreditation status, RN-to-resident ratio, MSA, and county-level income per capita. In the combined model, among resident characteristics, persons with Medicaid coverage had a 31 percent greater risk of PIRx. Residents with other mental disorders, excluding dementia, had 40 percent greater odds of having any PIRx than did their counterparts with no mental disorders. Residents taking less than five drugs monthly were only one-quarter as likely, and those taking five to nine drugs only half as likely, to have PIRx compared to those taking nine or more medications. Potentially inappropriate medication prescriptions also were 30 percent less likely to occur among residents with communication problems. There was no clear gradation in risk of PIRx by the number of ADL limitations.

Several facility characteristics were associated with PIRx in the combined model. Those living in NHs with JCAHO accreditation were 30 percent less likely to have PIRx. Those in the smallest NHs (fewer than 49 beds) were almost 50 percent less likely than those in the largest NHs (over 200 beds) to have any PIRx. Potentially inappropriate medication prescriptions were 40 percent more likely to occur among residents in NHs with less than 1 RN to every 20 residents, than among those in NHs with more than 1 RN to every 10 residents. There was no clear gradation in risk of PIRx by county-level income per capita.

Multivariate analysis of PIRx-severe found four resident factors to be significant: younger age cohort among the elderly (higher risk), averaging nine or more drugs per month (higher risk), mental disorders, not dementia (higher risk), and communication problems (lower risk). (Data are not shown in the table.)<sup>3</sup>

## DISCUSSION

### *Prevalence of PIRx*

One of the objectives of *Healthy People 2010* is to ensure regular review of the quality of medications used by elderly patients. With no widely accepted guidelines defining PIRx among elderly patients, Beers's criteria (1991, 1997) provide a de facto standard for examining drug use in this population. This study employed Beers's criteria to analyze data from the 1996 MEPS NHC

and found that, at a minimum, half of all elderly residents who had an NH stay of at least three months received a PIRx. More than one in three residents received PIRx at least once a month, every month, during their entire NH stay.

The PIRx rates among the NH population reported in this study were at the high end relative to previous findings. The duration of data collection in earlier studies varied from one month to one year, which affected the likelihood of capturing the occurrence of PIRx. This study evaluated stays that lasted from a minimum of three months up to one year, and over 85 percent of the residents had stays longer than six months. Furthermore, this study extended previous studies by examining all three types of PIRx: inappropriate drug choice, excess dosage, and drug–disease interactions.

Using Beers's criteria to assess PIRx in a large national database may misclassify some cases as inappropriate because certain clinical situations may warrant a particular medication or a higher dosage. For example, Beers's criteria indicate that amitriptyline is an inappropriate choice as an antidepressant for elderly patients because of its pronounced anticholinergic properties; some clinicians believe, however, that with careful monitoring, elderly patients with chronic neuropathic pain may receive low doses of amitriptyline as an appropriate treatment (Zhan et al. 2001). Such uncertainty reflects the complexity of prescribing for elderly patients, and underscores the need for studies to examine the effect of PIRx in this population and to determine evidence-based guidance.

Some types of PIRx were not considered here: *drug–drug interactions*, drugs prescribed for two conditions that can cause adverse drug reactions; *documentation error*, drugs that are not consistent with the reported diagnosis or poor documentation of the indication for use; and *redundancy*, multiple drugs within the same therapeutic class. Examining these types of PIRx would require more extensive information on residents' medical history and clinical situation than can be feasibly obtained in a national survey.

The most common PIRx found in this study—use of propoxyphene, diphenhydramine, hydroxyzine, oxybutynin, amitriptyline, cyproheptadine, iron supplement, and ranitidine—are generally not considered to have extremely dangerous effects. However, they are viewed as inappropriate because of their lack of efficacy compared to alternative agents or their potential for adverse side events. Propoxyphene, a narcotic analgesic that tends to induce dizziness and addictiveness, accounted for one-third of the PIRx cases. Other analgesics, such as aspirin and acetaminophen, may be safer and equally effective. Three antihistamines with potent anticholinergic effects (diphenhydramine, hydroxyzine, and cyproheptadine) collectively accounted

for one-quarter of the PIRx cases. Using nonsedating antihistamines, such as fexofenadine and loratadine, would have similar therapeutic effects (Meltzer 1991). Amitriptyline is considered inappropriate for treating depression among elderly patients; other antidepressant agents, such as selective serotonin reuptake inhibitors (SSRIs), are preferred (Omnicare 2000).

#### *Associated Resident and Facility Characteristics*

The therapeutic classes most involved in PIRx were psychotropic agents, perhaps explaining why the presence of mental disorders was associated with increased risk of PIRx. This is troubling in light of the 1986 NH reform to regulate the proper use of psychotropic medications, including antipsychotic, anxiolytic, and sedative drugs (Castle 2001). Use of these mind-altering agents as medical restraints to control NH residents has been documented and has been associated with PIRx (Schmidt et al. 1998).

The odds of having PIRx and PIRx-severe were lower among residents who had communication problems. Residents with communication problems in general took fewer drugs; they might have trouble communicating their health needs to receive appropriate care, thus avoiding PIRx exposure. The problem of underuse of beneficial therapies had been identified in the management of a broad range of chronic conditions among the elderly (Rochon and Gurwitz 1999).

Consistent with previous studies (Piercoro, Browning, and Prince 2000; Spore et al. 1997), the average number of drugs taken monthly was associated with the risk of having PIRx and PIRx-severe. Polypharmacy (usually defined as taking nine or more drugs) is of special concern for the elderly because they have higher susceptibility to side effects and develop toxicity to certain drugs more easily than younger people. Polypharmacy should remain an important policy focus because of its apparent association with PIRx exposure.

The risk of having PIRx-severe was 50 percent higher for residents among the youngest age group (65 to 74 years old) than for those in the oldest age group (85 and older) (data are not shown in the table).<sup>4</sup> Similar to other studies (Beers et al. 1992; Schmidt et al. 1998), younger elderly residents generally had significantly higher risks of receiving PIRx. Perhaps residents aged 85 and older were seen as more fragile and received more prudent prescribing by physicians. Admission to NHs at younger ages also is less common and may suggest that these residents had more complicated health problems, making them more difficult to manage and vulnerable to PIRx.

Residents with Medicaid coverage were at greater risk of receiving PIRx controlling for other factors. An explanation is not obvious, since Medicaid

patients received similar numbers of medication as those with no Medicaid coverage. Perhaps, if persons with private coverage or who self-pay remained under the care of their primary care physicians while in NHs, prescribing patterns for these residents would differ from those under the care of facility medical directors. It is important to pursue the reasons behind this relationship since Medicaid is the dominant payer for elderly NH residents.

The shortage of highly trained nurses has been a policy concern because of its potential pervasive adverse effect on the quality of care, especially in NHs (Harrington et al. 2000; Schmidt et al. 1998). This study found that residents in NHs with fewer RNs relative to the number of residents were at twice the risk of receiving PIRx as residents in NHs with more RNs on staff. These findings lend further support to the importance of RN staffing levels in maintaining quality of pharmaceutical care in NHs.

Similar to a previous study (Beers et al. 1992), smaller NHs were less likely to have PIRx occurrences, perhaps because with fewer beds it is easier to coordinate and manage individual care. Nursing homes currently volunteer to pay, and be inspected and accredited, by independent associations, such as JCAHO, for meeting a set of standards for operation. There is, however, uncertainty regarding how effective these accreditation bodies are in improving the quality of long-term care services. Accreditation by JCAHO was found to be associated with a lower risk of PIRx but it cannot be determined from this analysis whether this is an effect of the accreditation process or whether NHs that seek JCAHO accreditation differ from those NHs that do not on PIRx risk.

This study found no significant relationship between PIRx and weekly onsite availability of a consultant pharmacist. It is uncertain whether this measure adequately reflects the effectiveness of a consultant pharmacist on quality of prescribing in a NH. This issue is being further investigated by the American Society of Consultant Pharmacists' Fleetwood Model Studies (Harjivan and Lyles 2002). Weekly availability of mental health professionals also was not protective against the risk of PIRx. Since the availability of pharmaceutical and mental health expertise is usually regarded as improving quality of care in NHs, these relationships clearly need further investigation.

Additional analyses were performed to determine what characteristics were associated with missing prescribed medicine data, which could have biased the findings in this study. Only race, vital status, and MSA were found to be significantly related to missing data (Potter, Lau, and Dominici 2002), while PIRx and the other resident and facility characteristics investigated here were not.



## CONCLUSION

This study found that a substantial number of elderly NH residents in the United States were prescribed a PIRx in 1996, despite the fact that Beers's criteria contain mostly older medications, often considered obsolete (Gurwitz, Rochon, and the Food and Drug Administration 2002). Beers's criteria should be continuously updated based on empirical studies to reflect current knowledge of proper prescribing among elderly patients; this practice will help garner greater acceptance for the criteria from the health care provider community. With quality of care and patient safety as major public health concerns, effective policies are needed to avoid PIRx occurrences and improve the quality of prescribing among elderly residents in NHs.

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## NOTES

1. Results are available in Appendix A of the electronic version of this article.
2. Results are available in Appendix B of the electronic version of this article.
3. Results are available in Appendix C of the electronic version of this article.
4. Results are available in Appendix C of the electronic version of this article.

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**APPENDIX A. Patterns of potentially inappropriate medication prescriptions with the potential for severe harm (PIRx-severe).<sup>§</sup>**

| <b>Patterns of PIRx-Severe</b>            | <b>% of Residents with PIRx (S.E.)</b>        |
|---|---|
| <i>Number of PIRx-Severe</i> <sup>¶</sup> |   |
| Zero (no PIRx-severe)                     | 65.5 (1.39)                                   |
| At least one                              | 34.5 (1.39)                                   |
| One                                       | 27.8 (1.72)                                   |
| Two or more                               | 6.7 (1.72)                                    |
| <hr/>                                     |   |
|   | <b>% of Residents with PIRx-Severe (S.E.)</b> |
| <i>Type of PIRx-Severe</i> <sup>#</sup>   |   |
| Inappropriate drug choice                 | 83.6 (1.65)                                   |
| Excess dosage                             | 16.7 (1.67)                                   |
| Drug-disease interaction                  | 45.0 (0.64)                                   |

<sup>§</sup> Among residents, aged 65 and over, with a nursing home stay of 3 consecutive months or longer, 50.3% had a PIRx exposure in 1996. Percentages based on weighted data and available prescribed medicine data.

<sup>¶</sup> Number of PIRx-severe indicates the number of different drugs names that matched the Beers' criteria received during the year and not the frequency of use.

<sup>#</sup> Residents can have multiple types of PIRx exposures during the year.

Source: Center for Cost and Financing Studies, Agency for Healthcare Research and Quality, The 1996 Medical Expenditure Panel Survey Nursing Home Component.

**APPENDIX B. Top ten most common potentially inappropriate medications used by categories among residents, aged 65 and older, with a nursing home stay of three consecutive months or longer in 1996. §**

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**Inappropriate Drug Choice**

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- Propoxyphene (narcotic analgesic)
- Diphenhydramine (antihistamine)
- Hydroxyzine (antihistamine)
- Oxybutynin (gastrointestinal/antispasmodic agent)
- Amitriptyline (antidepressant)
- Cyproheptadine (antihistamine)

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**Excess Dosage**

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- Iron supplement > 325 mg daily
- Ranitidine (H2-blocker) > 300 mg for longer than 12 weeks

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**Drug-Disease Interaction**

---

- Chronic obstructive pulmonary disease and sedatives/hypnotics
- Constipation and strong anticholinergic agents

---

§ 51% of all nursing home users in 1996 (n=3,372). Results based on weighted data and available prescribed medicine data.

Source: Center for Cost and Financing Studies, Agency for Healthcare Research and Quality, The 1996 Medical Expenditure Panel Survey Nursing Home Component.

**APPENDIX C. Multivariate logistic regression analysis of resident and facility factors associated with having potentially inappropriate medication prescriptions with the potential for severe harm (PIRx-Severe).<sup>§</sup>**

| Characteristics   | Odds Ratio | PIRx<br>95% C.I. | P-value |
|---|------------|------------------|---------|
| <u>Resident Characteristics</u>                         |            |                  |         |
| <i>Age</i>  |            |                  |         |
| 65-74   | 1.56       | (1.13, 2.14)     | 0.006   |
| 75-84   | 1.26       | (1.00, 1.60)     | 0.050   |
| 85 and older  | 1.00       | (1.00, 1.00)     |         |
| <i>Sex</i>  |            |                  |         |
| Male  | 0.99       | (0.78, 1.24)     | 0.909   |
| Female  | 1.00       | (1.00, 1.00)     |         |
| <i>Race</i>   |            |                  |         |
| Black   | 0.88       | (0.56, 1.37)     | 0.561   |
| White/Hispanics/others                                  | 1.00       | (1.00, 1.00)     |         |
| <i>Medicaid coverage</i>                                |            |                  |         |
| Yes   | 1.26       | (0.96, 1.66)     | 0.100   |
| No  | 1.00       | (1.00, 1.00)     |         |
| <i>Admission before 1996</i>                            |            |                  |         |
| Yes   | 1.01       | (0.74, 1.38)     | 0.953   |
| No  | 1.00       | (1.00, 1.00)     |         |
| <i>Nursing home days in 1996</i>                        |            |                  |         |
| 90 to 120 days  | 1.13       | (0.67, 1.90)     | 0.654   |
| 121 to 200 days   | 0.99       | (0.70, 1.41)     | 0.961   |
| 201 to 280 days   | 1.44       | (1.01, 2.06)     | 0.044   |
| 281 to 366 days   | 1.00       | (1.00, 1.00)     |         |
| <i>Mental status</i>                                    |            |                  |         |
| Alzheimer's disease and other dementia                  | 1.17       | (0.92, 1.50)     | 0.199   |
| Other mental disorders only                             | 1.88       | (1.40, 2.51)     | < 0.001 |
| No mental disorder                                      | 1.00       | (1.00, 1.00)     |         |
| <i>Number of activities-of-daily-living limitations</i> |            |                  |         |
| 0 to 3  | 0.95       | (0.73, 1.24)     | 0.728   |
| 4 to 5  | 0.86       | (0.67, 1.11)     | 0.256   |
| 6   | 1.00       | (1.00, 1.00)     |         |
| <i>Behavior problems</i>                                |            |                  |         |
| Yes   | 1.25       | (0.99, 1.58)     | 0.066   |
| No  | 1.00       | (1.00, 1.00)     |         |
| <i>Communication problems</i>                           |            |                  |         |
| Yes   | 0.63       | (0.49, 0.82)     | 0.001   |
| No  | 1.00       | (1.00, 1.00)     |         |

| Characteristics                                     | Odds Ratio | PIRx<br>95% C.I. | P-value |
|---|------------|------------------|---------|
| <i>Average number of drugs per month</i>            |            |                  |         |
| Less than 5   | 0.22       | (0.16, 0.30)     | < 0.001 |
| 5 to < 9  | 0.49       | (0.39, 0.62)     | < 0.001 |
| 9 or more   | 1.00       | (1.00, 1.00)     |         |
| <br><u>Facility Characteristics</u>                 |            |                  |         |
| <i>Accreditation status</i>                         |            |                  |         |
| Yes   | 0.94       | (0.67, 1.32)     | 0.704   |
| No  | 1.00       | (1.00, 1.00)     |         |
| <i>Number of beds</i>                               |            |                  |         |
| 3 to 49   | 0.84       | (0.46, 1.55)     | 0.583   |
| 50 to 99  | 0.95       | (0.68, 1.34)     | 0.783   |
| 100 to 149  | 1.05       | (0.77, 1.43)     | 0.771   |
| 150 to 199  | 1.31       | (0.92, 1.88)     | 0.136   |
| 200 or more   | 1.00       | (1.00, 1.00)     |         |
| <i>Registered nurse (RN)-to-resident ratio</i>      |            |                  |         |
| Fewer than 1 : 20                                   | 1.27       | (0.93, 1.72)     | 0.134   |
| Between 1 : 20 and 1 : 10                           | 1.14       | (0.88, 1.48)     | 0.320   |
| Greater than 1 : 10                                 | 1.00       | (1.00, 1.00)     |         |
| <i>Metropolitan statistical area</i>                |            |                  |         |
| Yes   | 1.10       | (0.82, 1.49)     | 0.522   |
| No  | 1.00       | (1.00, 1.00)     |         |
| <i>County-level income per capita (in \$1,000s)</i> |            |                  |         |
| Less than or equal 20                               | 1.23       | (0.77, 1.94)     | 0.386   |
| > 20 to 25  | 1.01       | (0.68, 1.49)     | 0.966   |
| > 25 to 30  | 0.97       | (0.64, 1.47)     | 0.884   |
| More than 30  | 1.00       | (1.00, 1.00)     |         |

§ 51% of all nursing home users in 1996 (n=3,372). Percentages based on weighted data and available prescribed medicine data.

Source: Center for Cost and Financing Studies, Agency for Healthcare Research and Quality,  
The National 1996 Medical Expenditure Panel Survey Nursing Home Component.