# Trends in Use of High-Risk Medications for Older Veterans: 2004 to 2006

*Mary Jo V. Pugh, PhD,[ab] Joseph T. Hanlon, PharmD, MS,[cd] Chen-Pin Wang, PhD,[ab] Todd Semla, PharmD,[efg] Muriel Burk, PharmD,[efg] Megan E. Amuan, MPH,[h] Ashlei Lowery, MD,[i] Chester B. Good, MD,[dj] and Dan R. Berlowitz, MD, MPH[gk]*

**OBJECTIVES:** To examine the change in use of high-risk medications for the elderly (HRME), as defined by the National Committee on Quality Assurance's Healthcare Effectiveness Data and Information Set (HEDIS) quality measure (HEDIS HRME), by older outpatient veterans over a 3-year period and to identify risk factors for HEDIS HRME exposure overall and for the most commonly used drug classes.

**DESIGN:** Longitudinal retrospective database analysis.

**SETTING:** Outpatient clinics within the Department of Veterans Affairs (VA).

**PARTICIPANTS:** Veterans aged 65 by October 1, 2003, and who received VA care at least once each year until September 30, 2006.

**MEASUREMENTS:** Rates of use of HEDIS HRME overall and according to specific drug classes each year from fiscal year 2004 (FY04) to FY06.

**RESULTS:** In a cohort of 1,567,467, high-risk medication exposure fell from 13.1% to 12.3% between FY04 and FY06 ($P<.001$). High-risk antihistamines (e.g., diphenhydramine), opioid analgesics (e.g., propoxyphene), skeletal muscle relaxants (e.g., cyclobenzaprine), psychotropics (e.g., long half-life benzodiazepines), endocrine (e.g., estrogen), and cardiac medications (e.g., short-acting nifedipine) had modest but statistically significant ($P<.001$) reductions (range $-3.8\%$ to $-16.0\%$); nitrofurantoin demonstrated a statistically significant increase ($+36.5\%$; $P<.001$). Overall HEDIS HRME exposure was more likely for men, Hispanics, those receiving more medications, those with psychiatric comorbidity, and those without prior geriatric care. Exposure was lower for individuals exempt from copayment. Similar associations were seen between ethnicity, polypharmacy, psychiatric comorbidity, access-to-care factors, and use of individual HEDIS HRME classes.

**CONCLUSION:** HEDIS HRME drug exposure decreased slightly in an integrated healthcare system. Risk factors for exposure were not consistent across drug groups. Future studies should examine whether interventions to further reduce HEDIS HRME use improve health outcomes. **J Am Geriatr Soc 2011.**

**Key words: inappropriate prescribing; quality of care; aged; pharmacoepidemiology**

From the [a]South Texas Veterans Health Care System, Veterans Evidence-based Research and Implementation Center, San Antonio, Texas; [b]Department of Epidemiology and Biostatistics and [i]Division of Geriatrics, Gerontology and Palliative Medicine, University of Texas Health Science Center at San Antonio, San Antonio, Texas; [c]Division of Geriatric Medicine, Departments of Pharmacy and Therapeutics and Epidemiology and [j]Division of General Internal Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania; [d]Geriatric Research Education and Clinical Center and Center for Health Equity Research and Promotion, Veterans Affairs Pittsburgh Healthcare System, Pittsburgh, Pennsylvania; [e]Pharmacy Benefits Management Services, Department of Veterans Affairs, Hines, Illinois; Departments of [f]Medicine and [g]Psychiatry and Behavioral Sciences, Feinberg School of Medicine, Northwestern University, Chicago, Illinois; [h]Center for Health Quality, Outcomes, and Economic Research, Department of Veterans Affairs, Bedford, Massachusetts; and [k]School of Public Health, Boston University, Boston, Massachusetts.

Address correspondence to Mary Jo Pugh, VERDICT REAP, South Texas Veterans Health Care System (11C6), 7400 Merton Minter, San Antonio, TX 78023. E-mail: maryjo.pugh2@va.gov or pughm@uthscsa.edu

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Dr. Mark Beers first developed explicit criteria for potentially inappropriate prescribing in the elderly (PIPE), defined as medications rated by an expert panel as those whose risks outweigh their potential benefit in older adults, in 1991. They were subsequently updated in 1997 and 2003. Numerous studies have shown the rates of PIPE based on the Beers criteria over the past decade to be between 20% and 30% in older outpatients.[1–8] Several recent studies have identified small but significant reductions in PIPE as defined according to different versions of the Beers criteria.[9,10] For example, one study found a 3.9% reduction in PIPE (2003 Beers Criteria) between 1996 and 2005 in the United Kingdom despite a trend for an increase in the number of prescriptions overall during this time.[11]

In 2006, the National Committee on Quality Assurance (NCQA) developed a Healthcare Effectiveness Data


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and Information Set (HEDIS) quality measure to examine use of high-risk medications in the elderly (HRME) developed by an expert panel and based in part on the most-recent version of the Beers criteria.[12,13] The HEDIS HRME measure included some, but not all, of the drugs included in the Beers criteria, retaining those for which there was consensus that they should be avoided and that outcomes were considered to be of high severity. This more-refined measure is now used to benchmark the quality of medication management in older adults enrolled in Medicare and other managed care plans and thus is of interest to the Department of Veterans Affairs, Veterans Health Administration (VA).

Using VA data from October 1, 1999 to September 30, 2000, it was previously reported that the overall 1-year prevalence of HEDIS HRME exposure in older veteran outpatients was 19.6%.[14] To the best of the knowledge of the authors of the current study, the only published studies examining longitudinal use of HEDIS HRME as defined by this HEDIS quality measure have been reports by the NCQA.[15]

The objective of the current study was to examine the change in HEDIS HRME exposure in older veteran outpatients between 2004 and 2006 and to examine risk factors for HEDIS HRME exposure. Given that the foundation for the HEDIS HRME measure existed for longer than a decade before the refinement of the measure itself, it was hypothesized that reductions in the rates of HEDIS HRME drug use overall and within specific drug classes should have been evident by the mid-2000s. Moreover, it was hypothesized that risk factors for HEDIS HRME would be similar to those reported in previous studies using the Beers criteria and that they would be consistent across the major drug groups that constitute the HEDIS HRME measure.

## METHODS

### Study Design, Setting, and Sample

A longitudinal retrospective data analysis study was conducted using data from all VA outpatient clinics. The sample consisted of veterans aged 65 by October 1, 2003 (beginning fiscal year 2004 (FY04)) who received VA care at least once each year between FY03 and FY06. To examine change in a consistent sample over time, individuals who received sporadic VA care or who died during this period were not included in the analysis. Institutional review boards at three sites (University of Texas Health Science Center at San Antonio, Hines VA, and Bedford VA) approved this study.

### Data Sources

National VA inpatient, outpatient, and pharmacy data from FY03 (October 1, 2002–September 30, 2003) through FY06 (October 1, 2005–September 30, 2006) were obtained for individuals aged 65 and older at the beginning of FY04. A merged database was created using information from the VA National Patient Care Database records and all outpatient pharmacy prescription data from the VA Pharmacy Benefits Management database. Records were merged using an encrypted identifier that is consistent for each person across VA data sets.

### Measures

#### *Exposure: HRME*

Use of any of the HEDIS HRME drugs was identified using VA pharmacy data each year between FY04 and FY06. A measure of exposure was then created for overarching groups of drugs based on the VA Medication class system (Table 1) (http://www.pbm.va.gov/natform/vaclass.xls).

#### *Independent Variables*

Patient demographic characteristics (age, sex, race and ethnicity) were identified using data fields from VA administrative databases between FY03 and FY06. With the exception of race, these demographic characteristics are well documented and complete in the medical record. Because the process of recording race changed in 2002, race data are more likely to be missing than other aspects of VA administrative data. Findings from prior studies indicate that those with missing data were most often white and had low healthcare utilization and disease burden. For these demographic variables, a process was used in which VA data for previous years was looked back at and data in subsequent years was looked forward at to minimize missing data.

#### *Health Status Variables*

Health status variables in the analyses predicting HEDIS HRME exposure in FY06 included several measures of disease burden. Because prior studies indicated that individuals with greater disease burden as defined by more medications, more physical comorbidities and psychiatric conditions are at greater risk for potentially inappropriate prescribing,[7,16–18] these variables were controlled for. The number of unique medication classes each individual received during FY05 was first counted. *International Classification of Diseases, Ninth Revision, Clinical Modification*, codes found in VA inpatient and outpatient data (diagnoses in two outpatients or one inpatient) (FY03–05) were also used to identify individuals with physical and psychiatric conditions using the Selim comorbidity indices that were developed to control for disease burden in research studies involving veterans.[19,20] For physical conditions, the number of chronic disease states from 30 possible conditions included in the Selim Physical Comorbidity index was counted. The following psychiatric conditions included in the Selim Psychiatric Comorbidity Index were also identified: schizophrenia, bipolar disorder, depressive disorder, posttraumatic stress disorder, substance use disorder, and anxiety disorders. Because of the highly skewed distribution, individuals with zero, one, or two or more psychiatric conditions were identified. These measures of comorbidity have been previously associated with mortality, measures of health status, and PIPE.[14,21,22]

#### *Access-to-Care Variables*

Access-to-care variables in the analyses included a measure of copayment exemption and measures of geriatric care and primary care utilization in FY05. Copayment exemption was measured using the VA priority group. VA priority groups are associated with physical or mental health status and illness severity and socioeconomic status. Veterans with a service-connected disability of 50% or greater, or individuals who were catastrophically disabled, had very

**Table 1. High-Risk Medications in Older Adults**

| Drug Group | Drugs Included | Concerns Regarding Use |
|---|---|---|
| Amphetamines | Amphetamine/ dextroamphetamine, benzphetamine, dexmethylphenidate, pemoline, dextroamphetamine diethylpropion, methamphetamine, methylphenidate, phendimetrazine, phentermine | Dependence, hypertension, angina pectoris, and myocardial infarction |
| Antibiotics | Nitrofurantoin | Potential for renal impairment; safer alternatives available |
| Antihistamines | Diphenhydramine | Confusion and sedation |
| | hydroxyzine, promethazine, cyproheptadine, dexchlorpheniramine, tripelennamine | Potent anticholinergic properties |
| Cardiac medications and vasodilators | Dipyridamole (short acting) | Risk of orthostatic hypotension |
| | Nifedipine (short acting) | Potential for hypotension and constipation |
| | Isoxsuprine, ergot mesyloids | Lack of efficacy |
| Endocrine drugs | Estrogens | Carcinogenic potential |
| | Chlorpropamide | Syndrome of inappropriate antidiuretic hormone secretion; hypoglycemia |
| | Desiccated thyroid | Concerns about cardiac effects; safer alternatives available |
| Gastrointestinal antispasmodics | Dicyclomine, hyoscyamine, propantheline, atropine belladonna, scopolamine | Highly anticholinergic with uncertain effectiveness |
| | trimethobenzamide | Poor efficacy; can cause extrapyramidal effects |
| Nonsteroidal anti-inflammatory drugs | Ketorolac | Commonly causes asymptomatic gastrointestinal pathological conditions |
| Opioid pain relievers | Propoxyphene | Lack of efficacy; more adverse effects |
| | Meperidine | Lack of efficacy; confusion, falls, fractures, dependency |
| | Pentazocine | Falls, fractures, confusion, dependency, withdrawal |
| Psychotropic drugs | Diazepam, chlordiazepoxide, flurazepam | Prolonged sedation and increase the risk of falls |
| | Thioridazine, meprobamate | More central nervous system and extrapyramidal adverse effects than others |
| | Barbiturates | Highly addictive; more adverse effects than others |
| Skeletal muscle relaxants | Methocarbamol, cyclobenzaprine, carisoprodol, chlorzoxazone, metaxalone, orphenadrine | Anticholinergic adverse effects, sedation, and weakness; effectiveness at doses tolerated by older adults questionable |

low income, or had specific war-related experiences generally received a waiver for copayments associated with VA care.[21,23]

Because prior work found that geriatric care at some point the year before assessment was associated with lower risk of exposure to drugs included in the Beers criteria, individuals who received care in geriatric outpatient clinics or inpatient geriatric evaluation and management in FY05 were identified as having prior geriatric care.[24] Finally, because prior literature found that patients with many primary care visits the previous year were more likely to have an exposure to potentially inappropriate medications as measured by the Beers criteria, those with more-frequent visits to primary care ($\geq$5 in a year) may be sicker and thus at higher risk of HEDIS HRME exposure.[16,17] Based on prior studies and the empirical distribution, patients were classified as having 0 to 1, 2 to 4, or 5 or more primary care visits.

### Analysis

The demographic and health status characteristics of the cohort are first described, and then changes in exposure to HEDIS HRME overall and individual medication classes of older VA outpatients over the 3-year study period (FY04-06) were identified. Generalized estimating equation (GEE) analyses with a logit link (exchangeable working correlation) were used and applied to five unique samples of 100,000 randomly selected individual to determine whether changes over time in HEDIS HRME overall and drug classes were statistically significant. The averaged parameter estimates (change over time only) obtained from the five random samples were used, and standard errors were approximated for the entire population using the pooled standard errors.[25] Statistical significance of these pooled estimates was examined using the $Z$-score threshold: $\pm 2.33$ ($-2.33$ and 2.33 are 0.005 and 0.995 quantiles of the standard normal distribution). Logistic regression analyses were then used to identify demographic, health status, and access-to-care factors associated with risk of HEDIS HRME exposure overall in 2006 and for the four most commonly used HEDIS HRME drug classes. All statistical analyses were performed using SAS software (version 9, SAS Institute, Inc., Cary, NC).

## RESULTS

Of the 1,933,291 individuals who met age criteria in FY04, 1,567,467 received care between FY03 and FY06 and were included in this study. The mean age of individuals in this cohort in 2004 was 74.4 $\pm$ 5.8. Similar to other studies of older veterans, this cohort was primarily male (1,539,324, 98.2%) and white (1,060,366, 67.7%). Table 2 provides additional descriptive statistics for this cohort.

### Longitudinal Change in HEDIS HRME Exposure

Overall, the rates of HEDIS HRME exposure decreased over the study period (FY04, 205,179, 13.1%; FY05, 200,326, 12.8%; FY06, 193,456, 12.3%). This represents an absolute difference of 0.8% and a relative difference of 6.1% between FY04 and FY06. Figure 1 shows changes in HEDIS HRME exposure according to drug category over the study period. Most categories experienced small reduc-

**Table 2. Characteristics of Longitudinal Cohort**

| Characteristic | Overall (N = 1,567,467) | No HEDIS HRME Exposure (n = 1,374,016) | HEDIS HRME Exposure (n = 193,451) |
|---|---|---|---|
| Age, mean ± SD | 74.4 (5.8) | 76.5 (5.8) | 75.9 (5.8) |
| Sex, n (%) | | | |
| Male | 1,539,324 (98.2) | 1,352,233 (98.4) | 187,091 (96.71) |
| Female | 28,143 (1.8) | 21,783 (1.6) | 6,360 (3.3) |
| Race, n (%) | | | |
| White | 1,060,366 (67.7) | 919,575 (66.9) | 140,791 (72.8) |
| African American | 103,818 (6.6) | 87,261 (6.4) | 16,557 (8.6) |
| Hispanic | 52,925 (3.4) | 43,913 (3.2) | 9,012 (4.7) |
| Other | 19,719 (1.3) | 16,988 (1.2) | 2,731 (1.4) |
| Missing | 330,639 (21.09) | 306,279 (22.3) | 24,360 (12.6) |
| Unique medications, mean (± SD) | 6.4 (4.4) | 6.1 (4.1) | 9.2 (5.1) |
| Selim Physical Comorbidity Index, mean (± SD) | 2.5 (1.7) | 2.4 (1.6) | 3.1 (1.9) |
| Selim Psychiatric Comorbidity Index, n (%) | | | |
| 0 | 1,362,490 (86.9) | 1,212,466 (88.2) | 150,024(77.5) |
| 1 | 159,426 (10.2) | 127,866 (9.3) | 31,560 (16.3) |
| ≥2 | 45,551 (2.9) | 33,684 (2.5) | 11,867 (6.1) |
| Copayment status, n (%)* | | | |
| Exempt | 953,467(60.8) | 805,186 (58.6) | 148,281 (76.7) |
| Not exempt | 613,810 (39.2) | 568,662 (41.4) | 45,148 (23.3) |
| Geriatric care in 2003, n (%) | | | |
| Yes | 33,046 (2.11) | 29,020 (2.1) | 4,026 (2.1) |
| No | 1,534,421 (97.9) | 1,344,996 (97.9) | 189,425 (97.9) |
| Number of primary care visits, n (%) | | | |
| <2 | 382,741 (24.4) | 352,852 (25.7) | 29,889 (15.5) |
| 2–4 | 892,662 (57.0) | 787,111 (57.3) | 105,551 (54.7) |
| ≥5 | 292,064 (18.6) | 234,053 (17.0) | 58,011 (30.0) |

* 190 individuals had missing data for copayment status.
HEDIS HRME = high-risk medications for the elderly defined according to the Healthcare Effectiveness Data and Information Set quality measure; SD = standard deviation.

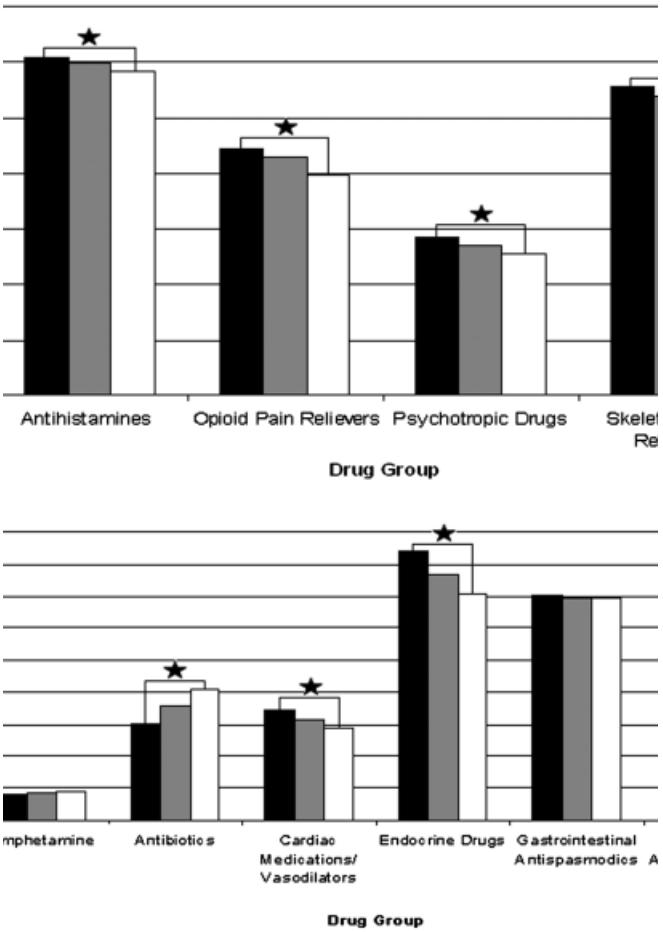


**Figure 1.** Exposure to high-risk medications in the elderly (HRME) according to drug group.
Trends in use of HRME: 2004 to 2006.
Significant at $P<.01$.
Changes in the number of older veterans exposed to specific high-risk medication classes between FY04 and FY06. Different scales are used for the most commonly used high-risk medication classes and those less commonly used to visualize the change in use over time: [ ■ ] FY04; [▩] FY05; [□] FY06

tions in use between FY04 and FY06, although there were relative increases of 36.5%, 10.3%, and 8.0% for antibiotics, amphetamines, and ketorolac (a nonsteroidal anti-inflammatory drug), respectively. Table 3 shows results of GEE analyses examining the statistical significance of HEDIS HRME over time in the five random samples of the population. Overall, exposure to HEDIS HRME was significantly lower in FY06 than FY04 (estimate −0.07, standard error 0.004, $Z$-score −15.59). There was no significant change in exposure for gastrointestinal antispasmodics, amphetamines, or ketorolac, but there were statistically significant reductions in high-risk opioid pain relievers (primarily propoxyphene), skeletal muscle relaxants, psychotropic drugs, endocrine drugs, and cardiac and vasodilator medications. There was also a statistically significant increase in exposure to nitrofurantoin.

Table 4 shows results of logistic regression models predicting HEDIS HRME exposure in FY06. Similar to a previous report using data from FY00, older individuals, African Americans (vs whites), those required to make copayments, and those with previous geriatric care were significantly less likely to have HEDIS HRME exposure. Women; Hispanics; and those with higher numbers of medications the prior year, psychiatric comorbidity, or higher primary care utilization were significantly more likely to have HEDIS HRME exposure.

Examination of the four types of the most commonly used HEDIS HRME suggested some consistency across medication types but also some variation with regard to predictors of HEDIS HRME exposure (Table 4). The effect of age, sex, number of medications, copayment requirement, and prior geriatric care were consistent across all drug groups. African Americans and Hispanics were less likely than whites to have opioid HEDIS HRME exposure and more likely to have antihistamine and skeletal muscle

**Table 3. Results of Pooled General Estimating Equations Assessing Change in Proportion of Exposure to Healthcare Effectiveness Data and Information Set (HEDIS) High-Risk Medications in the Elderly (HRME) According to Drug Category FY06 (vs FY04)**

| Drug Group | Estimate | Standard Error | *Z* Score |
|---|---|---|---|
| Any HEDIS HRME | – 0.07 | 0.004 | – 15.59* |
| Amphetamine | 0.10 | 0.045 | 2.09 |
| Antibiotic | 0.30 | 0.026 | 11.55* |
| Antihistamine | – 0.04 | 0.008 | – 4.40* |
| Cardiac medication or vasodilator | – 0.16 | 0.018 | – 8.84* |
| Endocrine drug | – 0.18 | 0.013 | – 14.05* |
| Gastrointestinal antispasmodic | – 0.026 | 0.016 | – 1.60 |
| Nonsteroidal anti-inflammatory drug | 0.03 | 0.064 | 0.49 |
| Opioid pain reliever | – 0.13 | 0.009 | – 13.92* |
| Psychotropic drug | – 0.11 | 0.009 | – 12.47* |
| Skeletal muscle relaxant | – 0.08 | 0.009 | – 9.19* |

* $P<.01$.

relaxant HEDIS HRME exposure. African Americans were also significantly less likely than whites to have psychotropic HEDIS HRME exposure, whereas Hispanics were significantly more likely to have such exposure. Individuals who were not married were more likely to have antihistamine and opioid HEDIS HRME exposure and less likely to have psychotropic or skeletal muscle relaxant HEDIS HRME exposure. The effect of high primary care utilization was associated with greater likelihood of HEDIS HRME exposure, with the exception of psychotropics, for which the effect was not significant for those with two to four visits and significantly greater for those with five or more visits. Finally, psychiatric comorbidity was not significantly associated with exposure to opioids or musculoskeletal relaxants.

## DISCUSSION

Findings from this study suggest that small, but statistically significant reductions in exposure to HRME overall defined using the HEDIS criteria occurred between 2004 and 2006 for older VA patients. Although the reductions in overall exposure were small during this time period (13.1% in FY04 to 12.3% in FY06), exposure was markedly lower than in a previous assessment of 19.6% in FY00 and similar to the rate of 12.9% reported in a previous national sample of retirees who had worked for the same company in 2003 to 2005.[26] The rates of exposure in the current study were considerably lower than those reported by the NCQA for 2006 among Medicare enrollees, with 23.1% of individuals meeting criteria for the denominator in 2006 having one or more HEDIS HRME exposures.[15] The VA's leadership in geriatric care, the active role of pharmacists in the VA, and VA formulary management may have contributed to the reduction. The VA created its One-National Formulary in

**Table 4. Logistic Regression Analysis Predicting Exposure to High-Risk Medications for the Elderly (HRME)**

| | Odds Ratio (99% Confidence Interval) | | | | |
|---|---|---|---|---|---|
| Variable | Overall HEDIS HRME | Antihistamines | Opioids | Psychotropics | Skeletal Muscle Relaxants |
| Demographic | | | | | |
| Age | 0.98 (0.98–0.98) | 0.99 (0.99–0.99) | 1.00 (1.00–1.00) | 0.98 (0.98–0.98) | 0.94 (0.94–0.94) |
| Female (vs male) | 1.95 (1.87–2.02) | 1.16 (1.11–1.20) | 1.29 (1.17–1.41) | 1.23 (1.10–1.36) | 1.44 (1.33–1.56) |
| Race (vs white) | | | | | |
| African American | 0.96 (0.93–0.98) | 1.16 (1.11–1.20) | 0.73 (0.69–0.77) | 0.75 (0.70–0.80) | 1.13 (1.09–1.18) |
| Hispanic | 1.08 (1.05–1.12) | 1.34 (1.28–1.41) | 0.32 (0.28–0.35) | 1.10 (1.02–1.19) | 1.41 (1.34–1.48) |
| Other | 0.97 (0.92–1.03) | 1.18 (1.08–1.28) | 0.69 (0.60–0.78) | 0.97 (0.85–1.12) | 0.98 (0.89–1.08) |
| Missing | 0.77 (0.75–0.78) | 0.67 (0.65–0.70) | 0.66 (0.64–0.69) | 0.88 (0.84–0.93) | 0.78 (0.75–0.81) |
| Not married (vs married) | 1.00 (0.99–1.02) | 1.14 (1.12–1.17) | 0.92 (0.90–0.95) | 0.88 (0.85–0.91) | 0.97 (0.95–1.00) |
| Health status factors | | | | | |
| Unique medications | 1.13 (1.12–1.13) | 1.12 (1.11–1.12) | 1.10 (1.09–1.10) | 1.12 (1.12–1.13) | 1.10 (1.10–1.10) |
| Selim Physical Comorbidity Index | 0.99 (0.98–0.99) | 0.96 (0.95–0.97) | 1.07 (1.06–1.08) | 0.89 (0.88–0.90) | 1.01 (1.00–1.02) |
| Selim Psychiatric Comorbidity Index (vs 0) | | | | | |
| 1 | 1.38 (1.35–1.40) | 1.35 (1.31–1.40) | 1.03 (0.99–1.08) | 2.79 (2.68–2.91) | 1.06 (1.03–1.10) |
| 2 or more | 1.51 (1.47–1.56) | 1.53 (1.46–1.60) | 0.92 (0.86–0.99) | 3.75 (3.54–3.96) | 1.06 (1.00–1.12) |
| Access-to-care factors | | | | | |
| Copayment status not exempt | 0.61 (0.60–0.62) | 0.49 (0.47–0.50) | 0.61 (0.59–0.63) | 0.56 (0.54–0.59) | 0.55 (0.53–0.56) |
| Received geriatric care | 0.73 (0.70–0.77) | 0.71 (0.66–0.77) | 0.69 (0.63–0.76) | 0.65 (0.57–0.73) | 0.65 (0.59–0.71) |
| Number of primary care visits (vs $<2$) | | | | | |
| 2–4 | 1.10 (1.08–1.12) | 1.10 (1.07–1.14) | 1.20 (1.16–1.25) | 1.00 (0.96–1.05) | 1.24 (1.20–1.29) |
| $\geq 5$ | 1.12 (1.09–1.15) | 1.20 (1.15–1.25) | 0.99 (0.95–1.04) | 0.87 (0.82–0.92) | 1.35 (1.30–1.41) |

HEDIS = Healthcare Effectiveness Data and Information Set.

2002 by freezing formularies at the facility and regional level and then creating a uniform formulary, which resulted in excluding drugs that had previously been on a number of regional formularies, such as propoxyphene.

Examination of change over time according to individual drugs and drug classes revealed some reduction in most drug classes, stability in others, and increases in nitrofurantoin. Reductions in use of skeletal muscle relaxants, psychotropic drugs, and opioid pain relievers is notable because recent studies have demonstrated that the use of these medications increases the risk of falls and fractures in older adults.[27–29]

One possible explanation for the increase in nitrofurantoin use is related to increasing resistance to common urinary tract pathogens such as *Escherichia coli* with common antibiotics (e.g., ciprofloxacin, trimethoprim/sulfamethoxazole). One in vitro study found that nitrofurantoin was effective in killing *E. coli* isolates in 98.1% of those with trimethoprim/sulfamethoxazole resistance and 89.6% of those with ciprofloxacin resistance.[30] Unfortunately, in vitro testing does not translate to nitrofurantoin being effective in older adults. The use of nitrofurantoin, a primarily renally cleared medication, should be avoided in individuals with estimated creatinine clearances less than 60 mL/min because insufficient concentrations reach the bladder to be capable of killing bacteria such as *E. coli*.[31,32] A recent study of veterans residing in a VA community living center found that this agent was in the top four suboptimally prescribed medications.[33] Of concern is a greater risk for serious adverse drug events with nitrofurantoin that include chronic, subacute, or acute pulmonary hypersensitivity reactions and peripheral neuropathy.

This study also adds to the understanding of risk factors for potentially inappropriate prescribing. Prior studies have examined a single drug such as propoxyphene or potentially inappropriate drugs in the Beers or HEDIS criteria as a single entity.[7,14–18,34,35] Neither of the aforementioned studies examined risk factors for the use of high-risk medications.[15,26] Consistent with a prior report and other studies examining exposure to potentially inappropriate medications, it was found that whites, women, and those with more medications were more likely to be exposed.[7,18] Examination of the four most commonly prescribed HEDIS HRME groups suggests that findings from studies of HEDIS HRME as a whole provide insufficient insight into this problem. In particular, the effects of race and psychiatric comorbidity and primary care utilization depend upon the type of potentially inappropriate medication.

With regard to race, African Americans were less likely to have exposure to suboptimal opioid and psychotropic medications than were whites, and Hispanics were also significantly less likely than whites to have exposure to opioid medications. The finding for African Americans is consistent with literature finding lower use of psychotropic medications and analgesics in blacks than in whites.[36,37] The finding for Hispanics is less clear, in part because many previous studies have not distinguished between blacks and Hispanics but rather evaluated them as "nonwhites."

Individuals with multiple psychiatric comorbidities had a lower risk of being prescribed high-risk opioids (e.g., propoxyphene). This finding may result from clinicians being less likely to prescribe opioids for pain in individuals receiving psychotropic medications for psychiatric comorbidities because of concern of that greater total central nervous system medication burden (e.g., opioids, benzodiazepines, antidepressants, antipsychotics) increase the risk of falls in older adults.[38]

A number of potential limitations should be noted. First, restriction of the assessment to individuals who received VA care between FY03 and FY06 may lead to selection bias. Although this was necessary to understand change in a consistent population, this may bias the results because individuals who were sicker and died during this 3-year period are not represented in the findings, but examination of the entire population revealed similar rates of exposure and trends overall and for HEDIS HRME drug groups (range 14.1% in FY04 to 12.6% in FY06) and predictors of exposure. Second, the assessment was restricted to medications received within the VA. It is possible that some HEDIS HRME were purchased outside the VA, and thus the assessment may be conservative. One potential problem is with medications that can be purchased over the counter (OTC), such as diphenhydramine. Substantial variation in the relationship between copayment status and HEDIS HRME exposure for antihistamines would support the idea that OTC medications affected lower risk for exposure differently in those with required copayments. Although small variations existed, the direction and magnitude of the copayment variable was similar across drug classes. A second concern regarding use of medications received from the VA is that implementation of Medicare Part D in January 2006 may have affected the findings.[39] Because a sudden, marked decrease in the average number of prescriptions per patient or marked decreases in exposure between 2005 and 2006 were not seen (Table 2), it is unlikely that the findings for FY06 were affected substantially. Moreover, the assessment occurred using data from a timeframe before the implementation of the HEDIS HRME measure. Because the Beers criteria from which the HEDIS HRME measure was derived have been in existence in various forms for nearly a decade, the time period examined for this assessment is not unreasonable. Moreover, this study provides a foundation for subsequent study of change in exposure by chronicling the years up to and including the first year of HEDIS HRME implementation. Residual confounding due to potential important factors for which information was not available (e.g., smoking) and HEDIS HRME cannot be excluded. Because this study provides information on change in prescribing on a national sample of older primarily male VA patients, it does not reflect prescribing in non-VA settings. Finally, because propoxyphene was removed from the market, it is expected that rates of HEDIS HRME exposure will fall significantly nationally. This would follow a consistent trend in the VA, where rates fell considerably due to formulary restrictions, but because opioids rank third among the most common high-risk drug classes, high-risk medication exposure continues to be of concern.

## CONCLUSION

This study found a small decrease in HEDIS HRME exposure between FY04 and FY06. These rates of exposure were lower in the VA than in 2006 Medicare data. Comparison

of the findings with those of an earlier study[14] suggests that exposure in the VA has fallen substantially between 2000 and 2006 but that only small changes occurred between 2004 and 2006. Moreover, variation in risk factors was found for different groups of HEDIS HRME drugs. Future studies should examine the effect of these reductions on overall health outcomes and measure the effects according to drug class because variation in outcomes may also be evident, depending on the medications and the conditions they treat.

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