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# Underuse of Indicated Medications Among Physically Frail Older US Veterans at the Time of Hospital Discharge: Results of a Cross-Sectional Analysis of Data From the Geriatric Evaluation and Management Drug Study

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## Abstract

**Background—**Medication underutilization, or the omission of a potentially beneficial medication indicated for disease management, is common among older adults but poorly understood.

**Objectives—**The aims of this work were to assess the prevalence of medication underuse and to determine whether polypharmacy or comorbidity was associated with medication underuse among physically frail older veterans transitioning from the hospital to the community.

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Dr. Wright conceptualized the project, assisted in the analysis, interpreted the data, and drafted the majority of the manuscript. Mr. Sloane and Dr. Pieper performed the bulk of the statistical analyses and assisted in the conceptualization of the project, the interpretation of the data, and the drafting of the manuscript. Dr. Ruby-Scelsi and Dr. Twersky participated in the conceptualization of the project and the drafting of the manuscript. Dr. Schmader and Dr. Hanlon were involved across the board in the conceptualization of the project, the interpretation of the data, and the drafting of the manuscript.

The authors report no financial interests in the materials or subject matter dealt with in this article. The authors have indicated that they have no other conflicts of interest regarding the content of this article.

**Methods—**This was a cross-sectional analysis of patients who were discharged from 11 US veterans' hospitals to outpatient care, based on data from the Geriatric Evaluation and Management Drug Study, a substudy of the Veterans Affairs Cooperative Study of geriatric evaluation and management. Patients were enrolled between August 31, 1995, and January 31, 1999. To qualify for the study, patients had to be aged ≥65 years, hospitalized in a medical or surgical ward for >48 hours, and meet ≥2 of the following criteria: moderate functional disability; recent cerebrovascular accident with residual neurological deficit; history of ≥1 fall in the previous 3 months; documented difficulty with walking (ie, requiring personal assistance or equipment), not including preadmission use of a wheelchair with ability to transfer to and from chair independently; malnutrition (admission serum albumin of 3.5 g/dL, <80% of ideal body weight, or recent ≥15-lb weight loss reported in admission history); dementia; depression; documented diagnosis of new fracture or revision needed of older fracture; unplanned admission within 3 months of previous admission; and prolonged bed rest. Clinical pharmacist/physician pairs reviewed medical records and medication lists and independently applied the Assessment of Underutilization (AOU) index to determine omissions of indicated medications. Discordances in index ratings were resolved during clinical consensus conferences. The primary outcome measure was the percentage of patients with ≥1 medication omission detected by the AOU. Multivariable logistic regression analyses identified factors associated with underuse.

**Results—**A total of 384 patients were included in the study. The majority (53.6%) were between the ages of 65 and 74 years, and the mean (SD) Charlson comorbidity index was 2.44 (1.93). Overall, 374 patients (97.4%) were men and 274 (71.4%) were white. Medication undertreatment occurred in 238 participants (62.0%). Diseases of the circulatory, endocrine/nutritional, musculoskeletal, and respiratory systems were the most commonly undertreated conditions. The indicated medications most likely to be omitted were nitrates for those with a history of myocardial infarction, multivitamins in those with malnutrition, and inhaled anticholinergics for chronic obstructive airways disease. Statistically significant factors associated with medication underuse included limitations in activities of daily living (adjusted odds ratio [AOR], 2.17 [95% CI, 1.27–3.71]; $P = 0.01$), being white (AOR, 1.70 [95% CI, 1.06–2.71]; $P = 0.03$), and Charlson comorbidity index (AOR, 1.13 for each 1-point increase [95% CI, 1.00–1.27]; $P = 0.04$). Discharge from a general medicine service as opposed to a surgical service was associated with lower risk of medication underuse (AOR, 0.61 [95% CI, 0.38–0.98]; $P = 0.04$).

**Conclusions—**Medication underuse was relatively common in this study. Patients with greater comorbidity, but not polypharmacy, had increased odds of undertreatment.

### Keywords

medication use; underutilization; comorbidity; transition of care; frail elderly

## INTRODUCTION

Medication underutilization is common among older adults and is thought by some groups to be more common than polypharmacy (ie, overuse of medications).[1–7] *Medication underutilization* is defined as the omission of an indicated and potentially beneficial medication for the treatment or prevention of a disease or condition.[1,2,4,7,8] Most previous studies in older adults have focused on omission of medications for specific conditions using explicit criteria.[5,6,9,10] Some examples of underuse from these studies included not prescribing platelet inhibitors for patients with a history of stroke or calcium supplements for those at risk of osteoporotic fracture.[3,6,8] These previous studies of medication underuse were limited because they did not consider contraindications to omitted medications or patient preferences. Both Lipton et al[7] and Steinman et al[11] conducted studies that overcame these limitations by having trained clinicians apply reliable, structured implicit (ie, judgment-based) process measures after review of medical records.

The reasons for underuse of medications in older adults are poorly understood. One of the biggest challenges faced by those who care for older patients, both in the hospital and in the community, is balancing the management of multiple complex medical problems simultaneously without creating suboptimal prescribing problems. As such, the relationship between comorbidity and medication underuse intuitively ought to be important, but its precise nature has not been adequately explored. A better understanding of how polypharmacy, the degree of comorbidity, and other factors influence medication underuse may lead to useful strategies to curtail this potentially harmful oversight in the care of physically frail older patients.[1–4,6,7,12–15] Because hospital discharge represents an important transition in the care of older patients, it provides a key opportunity to address medication underuse. For this reason, the Joint Commission on Accreditation of Healthcare Organizations selected hospital discharge as the point in time of a hospitalization to apply quality-of-care measures for the medication treatment of a variety of cardiac conditions (eg, angiotensin enzyme inhibitor in a patient with class II/IV systolic heart failure).[16]

Given the limited information regarding underuse of medications in physically frail older patients at time of hospital discharge, the purposes of this study were to assess the prevalence of medication underuse and to determine whether polypharmacy or comorbidity was associated with medication underuse among physically frail older veterans transitioning from the hospital to the community.

## PATIENTS AND METHODS

### Study Design and Participants

This was a cross-sectional study of 384 physically frail older veterans at the time of discharge from a hospital medical or surgical ward to outpatient care. We used data collected for the Geriatric Evaluation and Management (GEM) Drug Study, a substudy of the Veterans Affairs (VA) Cooperative Study of geriatric evaluation and management.[17] Detailed descriptions of the GEM Drug Study design and methodology have been published previously.[18,19] Briefly, investigators conducted the study at 11 VA Medical Centers (VAMCs) and followed 1388 participants. To participate, patients had to be aged ≥65 years, hospitalized in a medical or surgical ward for >48 hours, and meet criteria for frailty as defined by the parent study.[17,18] Patients were enrolled between August 31, 1995, and January 31, 1999. To qualify as frail, participants met ≥2 of the following criteria: (1) moderate functional disability; (2) recent cerebrovascular accident with residual neurological deficit; (3) history of ≥1 fall within the previous 3 months; (4) documented difficulty with walking (ie, requirement of personal assistance or equipment), not including use of a wheelchair before admission and ability to transfer independently; (5) malnutrition (admission serum albumin of 3.5 g/dL, <80% of ideal body weight, or recent ≥15-lb weight loss reported in admission history); (6) dementia; (7) depression; (8) documented diagnosis of new fracture or revision needed of old fracture; (9) unplanned admission within 3 months of previous admission; and (10) prolonged bed rest.[17,18] Those who died before hospital discharge or who were discharged to a nonindependent post–acute-care setting were excluded. The VAMC research and human subjects committees at each study site approved the study prior to data collection, and the University of Pittsburgh Institutional Review Board exempted this study from review as an analysis of previously collected data.

### Data Collection

Two of the coauthors (J.T.H. and K.E.S.) trained research assistants at each VA site to abstract the data from the medical record using standardized procedures and forms that had performed well in pilot testing for accuracy of data collection.[18] Research assistants at each VA site created a study chart from the entire paper and computerized medical record of the patient, using the

procedures and forms for chart abstraction that were developed and tested by the authors. The data in the abstract included the following: (1) summary information, including the hospital admission list, discharge summaries from the index admission and from 12 months before and 12 months after the index admission, and the problem list; (2) index admission information, including the history and physical, nurse's inpatient notes, progress notes, consults, vital sign flow sheet, nutrition summary, and orders; (3) outpatient information, including outpatient visit list, progress notes, and consults; (4) laboratory and diagnostic tests at 12 months before and 12 months after the index hospitalization, including drug levels; and (5) medication documents, including the VA medication profile, adverse reaction tracking report, index admission medication administration record, inpatient nurse's discharge orders, and VA action profile.

These trained research assistants collected data about patients' sociodemographics, health status, and access to health care from the participants and their medical records. The collected data included medical information (ie, active medical problems, functional status, self-rated health, admitting service, and lists of prescription and nonprescription medications along with strength and frequency of administration) about each participant.

## Assessment of Medication Underuse

To detect underuse of medications, a clinical pharmacist and a physician independently reviewed each participant's abstracted medical record, list of medical conditions, and prescribed medications at the time of hospital discharge. For each chronic condition, the clinician pair used the Assessment of Underutilization (AOU) index to identify underused (ie, omitted) but indicated medications.[20,21] This instrument has demonstrated good interrater reliability between 2 clinical pharmacists ($\kappa = 0.64$).[20,21] The 2 clinicians had the choice of 3 ratings for each condition: A = no omission; B = marginal omission (eg, omitted by prescribers because of patient preferences, goals of care, use of alternatives to pharmacotherapy, physician desire to discontinue medications to focus on symptom management at end of life, or other documented contraindication); C = omission.[20,21] The AOU provides specific definitions, instructions, and examples for the reviewers. Some examples of these 3 ratings are as follows. An example of *no omission* (A rating) would be a patient with a problem list that included hypertension, osteoarthritis, and constipation and prescriptions for hydrochlorothiazide, ibuprofen, and psyllium (ie, no drug omitted for each condition). An example of *marginal omission* (B rating) would be if the patient or physician preferred not to treat hyperlipidemia with a statin because of previous adverse events or limited life expectancy. An example of *omission* (C rating) would be a patient with a history of myocardial infarction and no contraindications to β-blocker therapy who did not have a prescription for such therapy. Any discordances in ratings were resolved during clinical consensus conferences held throughout the evaluation period.

*Underuse*, a dichotomous dependent variable, was operationally defined using the ratings assigned by the AOU: no underuse (A and B) versus underuse/omitted medication (C). For all conditions with evidence of underuse, a trained research nurse coded each individual medical condition with codes from the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*). To ensure that the *ICD-9-CM* codes were applied consistently, one of the investigators (K.E.S.) verified the accuracy by reevaluating every tenth patient. A trained clinical pharmacist (C.R.-S.) applied VA medication class codes to classify underused or omitted medications. For descriptive purposes, the number of undertreated conditions, along with the corresponding class or classes of omitted medications, was calculated at the individual level. For the purpose of analyses, the primary outcome measure was the percentage of patients with ≥1 medication omission detected by the AOU.

## Primary Independent Variables

*Polypharmacy* has traditionally been defined by a total count of medications, regardless of whether they are appropriate and indicated by the patient's medical conditions. However, we recognized that, in terms of quality assessment, a distinction should be made between use of unnecessary medications and use of multiple necessary medications.[5,11,19,22] Therefore, we performed an a priori examination of polypharmacy in 2 ways. First, we defined *unnecessary medication* use (ie, overuse) as taking ≥1 medication found to be inappropriate because of lack of indication, lack of effectiveness, or duplication of another medication on the participant's medication list.[22–24] Unnecessary medication use was described with a dichotomous variable (*yes/no*). Second, the remaining *necessary medications* were described with categoric variables (≥9, 5–8, and 0–4 necessary medications). Necessary medication use was represented by a total count of indicated, effective medications taken by the participant. Thus, the percentages of patients with necessary and unnecessary medications were both primary independent variables.

*Comorbidity* was added to the model as another primary independent variable because the presence of multiple chronic diseases, or of certain combinations of chronic medical problems, could have been associated with undertreatment.[25–27] However, rather than a simple count of medical conditions, we used a measure of comorbidity, the Charlson comorbidity index, that accounted for the overall severity of impairment or burden related to cumulative illness caused by coexisting chronic conditions.[25–27] A continuous variable for the Charlson comorbidity index score (range of possible scores, 0–34, with higher numbers representing more comorbidities) was calculated based on the medical impact of 19 chronic conditions (myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disorder, ulcer disease, mild liver disease, diabetes mellitus, hemiplegia, moderate or severe renal disease, diabetes mellitus with end-stage organ damage, any tumor, leukemia, lymphoma, moderate or severe liver disease, metastatic solid tumor, or AIDS) documented in the medical record.[25–27]

## Other Independent Variables

A modified health care service use model was used to control for other factors potentially associated with medication underuse.[28,29] These independent variables were grouped into 3 domains: (1) sociodemographics, (2) health status, and (3) access to health care.[28,29] The sociodemographic characteristics were represented by dichotomous measures for age (65–74 or ≥75 years), sex, race (nonwhite or white), level of education (high school or greater, did not graduate high school), marital status, and employment.

Health status characteristics were represented by dichotomous variables for self-rated health (excellent/very good/good or fair/poor), the presence of chart documentation of certain conditions (ie, falls, depression, malnutrition), and the need for help with ≥1 basic activity of daily living (ADL).[30] Specific characteristics that may have facilitated or hindered access to health care were represented by dichotomously scored variables (1 = *yes*, 0 = *no*) for admission to medical or surgical service and by the presence of multiple prescribers (1 or >1).

## Analyses

Baseline descriptive statistics for the sample were presented as frequencies and percentages for all dichotomous and categorical variables. Continuous variables were represented by mean (SD) values. The presence of medication underuse was described at the participant level by both disease category and medication class using the *ICD-9-CM* and VA Medication Classification coding systems, respectively. The prevalence of undertreatment by disease category was calculated as the percentage of veterans in the sample who had been undertreated for ≥1 condition in that category.

Logistic regression was used in bivariable analyses to identify factors associated with medication underuse. Stepwise logistic regression with $\alpha = 0.20$ was used to select variables within each of the 3 domains of variables (sociodemographic, health status, and access to health care characteristics).[31] Variables selected from the 3 logistic regressions were included in a final logistic regression, and a stepwise method with $\alpha = 0.05$ was used to select the variables for the final model. The 2 measures of polypharmacy and the comorbidity variable were then forced into the final model. The Hosmer-Lemeshow testing for goodness of fit was conducted.[31] We also conducted collinearity diagnostic testing. SAS 9.1 software (SAS Institute Inc., Cary, North Carolina) was used to perform all analyses.

## RESULTS

The characteristics of the 384 patients included in this study are presented in Table I. Overall, 374 patients (97.4%) were men and 274 (71.4%) were white. Only 13 patients (3.4%) were aged >85 years. The mean (SD) Charlson comorbidity index was 2.44 (1.93), indicating that the typical disease severity or burden for this cohort fell into the mild to moderate range. Most patients (312 [81.3%]) needed help to perform basic daily functions, and 239 (62.2%) described their health as fair or poor. In addition, most patients (302 [78.6%]) were discharged to home with ≥5 medications (mean [SD], 6.8 [3.3] medications). The research team identified unnecessary medication use among 170 patients (44.3%) at the time of hospital discharge.

### Undertreated Conditions

Two hundred thirty-eight patients (62.0%) had evidence of medication underuse. The mean (SD) number of undertreated conditions was 1.04 (1.16). Ninety-nine patients (25.8%) had evidence of ≥2 conditions for which medications were omitted. Most patients with medication underuse at discharge (87.3%) also had problems previously during their hospital stay.

Table II shows the prevalence of underuse of specific medications for specific medical conditions. When undertreatment of multiple conditions (eg, coronary atherosclerotic disease and osteoarthritis in the circulatory and musculoskeletal systems) across multiple categories occurred, an individual was represented in this table more than once as being undertreated. Undertreatment occurred most commonly in the circulatory system, endocrine/nutritional, musculoskeletal system, and respiratory system disease categories.

Table II also shows the distribution of the most commonly underprescribed but indicated medication classes most often omitted. For example, in those with a history of myocardial infarction, the most commonly omitted drugs in rank order were nitrates (n = 33), aspirin (n = 15), and β-blockers (n = 7). Angiotensin-converting enzyme inhibitors were the most common class of drugs omitted in those with heart failure (n = 16) and those with diabetes mellitus (n = 17). In 23 instances, a medication subclass that was indicated as a treatment for >1 condition (eg, omission of aspirin for diabetes mellitus and history of myocardial infarction) in the same individual was omitted.

Table III shows the results of the bivariable and multivariable logistic regression analyses evaluating associations between the independent variables and underuse of indicated medications at the time of hospital discharge. In the adjusted model, neither the total number of medications prescribed nor unnecessary medication use at hospital discharge were significantly associated with underuse. However, greater comorbid disease severity was associated with increased odds of undertreatment at hospital discharge (adjusted odds ratio [AOR], 1.13 for every 1-point increase [95% CI, 1.00–1.27]; $P = 0.04$).

In the adjusted model, the only sociodemographic covariable associated with greater odds of underuse was being white (AOR, 1.70 [95% CI, 1.06–2.71]; $P = 0.03$). In terms of health status,

physical function limitation was associated with increased odds of undertreatment at hospital discharge (AOR, 2.17 [95% CI, 1.27–3.71]; $P = 0.01$). Discharge from a general medicine service, as opposed to a surgical service, was associated with lower risk of medication underuse (AOR, 0.61 [95% CI, 0.38–0.98]; $P = 0.04$). Collinearity diagnostics indicated the absence of any problems related to excessive intercorrelation among the independent variables. The Hosmer-Lemeshow statistics,[31] shown in Table III, indicated an adequate fit of the logistic model to the data ($\chi^2 = 11.9$; $df = 8$; $P = 0.16$).

## DISCUSSION

This was one of few studies to examine underuse of medications across multiple comorbid medical conditions using a reliable structured implicit (ie, judgment-based) process measure. It is particularly noteworthy that nearly two thirds of the veterans in this study (62.0% [238/384]) were discharged from a hospitalization with ≥1 undertreated condition (ie, without medications they probably should have received). It is also interesting to note that most problems with medication underuse were present earlier during their hospital stay.

This finding was consistent with the medication underuse rate of 55% found in another study of 236 older outpatients,[7] and with the rate of underuse (64%) observed in a study of community-dwelling veterans.[11] It is worth noting that both the current study and the Steinman et al[11] study found a similar distribution of medication underuse across therapeutic classes (eg, primarily cardiovascular agents and antiplatelet agents). However, Lipton et al[7] found that cholesterol-lowering agents, oral hypoglycemics for patients with diabetes mellitus, and pain medications were among the most commonly omitted medications in a sample of older patients.

In the present study, polypharmacy (as defined by 2 different measures) was not associated with medication underuse. Steinman et al[11] previously reported that underuse occurred regardless of how many medications an older person took; Kuijpers et al[5] found that most underprescribing occurred in those who took the most medications, but their study was limited by the absence of control for other demographic or health-status factors. The current study showed that greater overall comorbidity or functional status limitation was associated with medication underuse, whereas the Steinman et al[11] and Kuzuya et al[6] studies limited their analyses to associations between underuse and specific individual medical conditions. Disease severity or burden may be a more meaningful measure of associations between comorbidity and underuse. In fact, others have speculated that comorbidity plays a major role in the quality of prescribing overall.[6,25,32,33] Kuzuya et al[6] similarly concluded that ADL function influenced underuse, particularly in older frail Japanese patients with certain chronic conditions such as dementia, cardiovascular disease, and diabetes mellitus. Another possible explanation is that those with functional status limitations may be reluctant or unable to manage more complicated medication regimens.

We found 2 other factors associated with higher rates of medication underuse: white race and receiving hospital care in a surgical ward. We recognize that race alone should not determine treatment of important conditions in older adults. Finding that being white was associated with underuse contrasted with a recent study in the managed care setting which reported that older black patients with established ischemic heart disease (ie, history of myocardial infarction) or its risk equivalent (ie, those with diabetes mellitus) had worse cholesterol control than did older white patients.[34] However, the findings of that study by Trivedi et al[34] were not consistent with the results of a study by Asch et al[35] that included a random sample of people living in 12 US communities. Asch et al[35] found that blacks had higher quality-of-care scores for chronic care than did whites, but did not report whether those findings also held true for those aged ≥65 years. On the other hand, medication underuse after hospitalization in the surgical service may be explained if surgeons focused more on perioperative care than on the management of

chronic medical conditions. The underuse of medications at the time of discharge from surgical services may represent an opportunity for geriatric consultation and optimization of medications at hospital discharge and during transition of care between hospital wards or to the community setting.

The present study contributed several important findings. Some of the underused medications and conditions (eg, antiplatelet agents and myocardial infarction) were critically important for patient health, and they now serve as the foci of current quality of care and performance measures.[16]

The findings of the current study also represent an opportunity for improved patient care. Furthermore, the underprescribing of seemingly indicated medications may have been influenced by comorbidity given that this study found that comorbidity (based on disease severity) and disability were important factors for underuse. The question of whether it is appropriate to withhold a medication for a given condition in a patient with increased multiple disease severity and disability is an important consideration and represents a fundamental clinical challenge for clinicians caring for frail older adults.[36] For patients with multiple diseases and disability, inpatient clinicians should prescribe medications for those conditions on which treatment will have an immediate, clinically important impact, assuming no contraindications (eg, congestive heart failure and β-blockers), as soon as they are identified in the hospital. For other conditions that should be treated but do not require immediate attention (eg, hip fracture and bisphosphonates), coordination with the patient's primary provider is essential. We recognize that inpatient clinicians will be reluctant to add a medication at the time of hospital discharge because there may be potential problems, such as inadequate monitoring, in the transition back to outpatient care.

The potential limitations of this study's methodology should also be noted. First, the cross-sectional design prevented identification of causal relationships between the factors studied and medication underuse. Second, the analyses used data about underuse that were obtained from chart reviews; these data could represent either an overestimate or an underestimate of medication underuse if clinical factors influencing the prescribing decision and the influence of patient preferences on medical decision making were not recorded in the chart. Third, the reliability and validity of the AOU has not been extensively tested, despite having been used in a number of published studies.[11,18,20,21,24] Finally, this study sample consisted of a fairly homogeneous group of frail older veterans, so the findings may not be readily generalizable to other groups of older adults.

## CONCLUSIONS

This study found that medication underuse was relatively common among physically frail older US veterans being discharged from the hospital to the community. The analyses suggested that older adults with limited ability to perform ADLs or greater comorbidity were the most likely to experience undertreatment. Further work is needed to address the important public health problem of underuse of essential medications in older adults.

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## Table I

Characteristics of 384 physically frail US veterans aged ≥65 years at the time of discharge from 11 veterans' hospitals, based on retrospective analysis of data from the Geriatric Evaluation and Management Drug Study.[17] Data are no. (%) unless otherwise indicated.

| Variable | Value |
|---|---|
| Sociodemographic factors | |
| Age group, y | |
| 65–74 | 206 (53.6) |
| >74–85 | 165 (43.0) |
| >85 | 13 (3.4) |
| Sex | |
| Male | 374 (97.4) |
| Female | 10 (2.6) |
| Race | |
| White | 274 (71.4) |
| Nonwhite | 110 (28.6) |
| Marital status | |
| Married | 200 (52.1) |
| Not married | 184 (47.9) |
| Education | |
| Did not complete high school | 212 (55.2) |
| Completed high school | 172 (44.8) |
| Employment | |
| Not employed | 365 (95.1) |
| Employed | 19(4.9) |
| Health status | |
| Charlson comorbidity index, mean (SD) | 2.44 (1.93) |
| History of falls | 70 (18.2) |
| Depression | 37 (9.6) |
| Malnutrition | 122 (31.8) |
| Self-rated health | |
| Fair or poor | 239 (62.2) |
| Excellent, very good, or good | 145 (37.8) |
| Needs help with ≥1 activity of daily living | 312 (81.3) |
| Access to health care | |
| Primary hospital service | |
| Medicine | 257 (66.9) |
| Surgery | 127 (33.1) |
| >1 Prescriber | 19(4.9) |
| Number of necessary prescription medications* | |
| 1–4 | 82 (21.4) |
| 5–8 | 159 (41.4) |
| ≥9 | 143 (37.2) |

| Variable | Value |
|---|---|
| Unnecessary medication use | 170 (44.3) |

* Medication count excluding unnecessary medication use.

## Table II

Prevalence of medication underuse among 384 physically frail US veterans aged ≥65 years at the time of discharge from 11 veterans' hospitals, based on retrospective analysis of data from the Geriatric Evaluation and Management Drug Study.[17]

| Major Diagnosis Category (*ICD-9-CM* Codes) | No. (%) of Undertreated Patients in Category* | Most Commonly Undertreated Condition in Each Diagnosis Category (No. of Patients) | Most Commonly Underused Medications (No. of Patients)†‡ |
|---|---|---|---|
| Circulatory system disorders (390–459) | 141 (36.7) | Acute myocardial infarction (50)<br>Heart failure (25) | Nitrates (33); aspirin (15); β-blockers (7)<br>Angiotensin-converting enzyme inhibitors (16) |
| Endocrine, nutritional, metabolic, and immunologic disorders (240–289) | 89 (23.2) | Protein calorie malnutrition (39)<br>Diabetes mellitus (32) | Multivitamins (39)<br>Angiotensin-converting enzyme inhibitors (17); oral hypoglycemics (5) |
| Musculoskeletal and connective tissue disorders (710–759) | 38 (9.9) | Osteoarthritis (21)<br>Osteoporosis (10) | Acetaminophen (18); opioid analgesics (2)<br>Calcium (7) |
| Respiratory system disorders (460–519) | 36 (9.4) | Chronic obstructive airways disease (32) | Inhaled anticholinergic bronchodilators (21) |
| Mental disorders (290–319) | 15 (3.9) | Depression (7) | Selective serotonin reuptake inhibitors (5) |
| Diseases of nervous system and sense organs (320–389) | 13 (3.4) | Glaucoma (9) | β-Blocker ophthalmic agents (7) |
| Digestive system disorders (520–579) | 11 (2.9) | Peptic ulcer disease (4)<br>Constipation (4) | Histamine-2 receptor blockers (4)<br>Laxatives (4) |
| Overall | 238 (62.0)* | | |

ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification.

*Some veterans may have experienced undertreatment in >1 diagnostic category. Underuse of medications for multiple conditions within a single major diagnostic category was only counted once.

†Some veterans experienced underuse of >1 class of medications or underuse of multiple medications in a single class. Underuse of multiple medications within a single major medication class was counted only once per veteran.

‡An omitted medication may have counted more than once per veteran if that individual had multiple conditions for which a medication was considered indicated to treat.

## Table III

Factors associated with medication underuse among 384 physically frail US veterans aged ≥65 years at the time of discharge from 11 veterans' hospitals, based on retrospective analysis of data from the Geriatric Evaluation and Management Drug Study.[17*]

| Risk Factor | Crude Odds Ratio (95% CI) | *P* | Adjusted Odds Ratio (95% CI) | *P* |
|---|---|---|---|---|
| Primary independent variables | | | | |
| No. of medications | | | | |
| ≥9 | 1.08 (0.60–1.92) | 0.81 | 0.95 (0.50–1.78) | 0.86 |
| 5–8 | 1.13 (0.70–1.81) | 0.62 | 1.07 (0.64–1.77) | 0.81 |
| 0–4[†] | | | 1.00 | |
| Unnecessary medication use | 1.10 (0.73–1.66) | 0.66 | 0.99 (0.65–1.53) | 0.98 |
| Charlson comorbidity index for every 1-point increase | 1.11 (0.99–1.23) | 0.07 | 1.13 (1.00–1.27) | 0.04 |
| Other independent variables | | | | |
| Sociodemographics | | | | |
| Age group, y | | | | |
| 65–74[†] | 1.00 | | | |
| 75–85 | 1.21 (0.79–1.85) | 0.37 | | |
| >85 | 1.08 (0.34–3.41) | 0.89 | | |
| Male sex | 3.90 (0.99–15.33) | 0.05 | | |
| White race | 1.52 (0.97–2.38) | 0.07 | 1.70 (1.06–2.71) | 0.03 |
| Married | 1.22 (0.81–1.85) | 0.34 | | |
| Completed high school | 0.95 (0.63–1.44) | 0.81 | | |
| Employed | 0.43 (0.17–1.10) | 0.08 | 0.40 (0.15–1.05) | 0.06 |
| Health status | | | | |
| ≥1 Fall in last 3 months | 1.14 (0.67–1.96) | 0.63 | | |
| Depression | 0.90 (0.45–1.80) | 0.77 | | |
| Malnutrition | 1.27 (0.81–1.99) | 0.29 | | |
| Fair or poor self-rated health | 1.29 (0.85–1.97) | 0.23 | | |
| Need for help with ≥1 ADL | 2.08 (1.24–3.49) | 0.01 | 2.17 (1.27–3.71) | 0.01 |
| Access to health care | | | | |
| Primary hospital service | | | | |
| Medicine | 0.68 (0.43–1.06) | 0.09 | 0.61 (0.38–0.98) | 0.04 |
| Surgery[†] | | | 1.00 | |
| Multiple prescribers | 0.85 (0.33–2.15) | 0.73 | | |

ADL = activity of daily living.

*Hosmer-Lemeshow goodness-of-fit test ($\chi^2 = 11.9$; $df = 8$; $P = 0.16$) suggests adequate model fit.[31]

†Referent.