Inappropriate Medication Prescribing in Residential Care/Assisted Living Facilities

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OBJECTIVES: To identify the extent to which inappropriately prescribed medications (IPMs) are administered to older patients in residential care/assisted living (RC/AL) facilities and to describe facility and resident factors associated with receipt of one or more IPMs.

DESIGN: Cross-sectional study of a stratified, representative sample of 193 facilities in four states.

SETTING: We identified representative geographic regions within Florida, New Jersey, North Carolina, and Maryland and drew from within them a stratified random sample of 193 RC/AL facilities. Three subtypes of facilities were included in the sample: small homes (<16 beds), larger "new-model" homes, and larger "traditional" homes.

PARTICIPANTS: Within each larger home, a random sample of residents aged 65 and older was approached for consent; in smaller homes all residents were approached. The overall enrollment rate was 92%; 2,078 residents were enrolled.

MEASUREMENTS: Questionnaires and on-site observations were used to gather data on facility administration and staffing and resident characteristics. All prescription and nonprescription medications taken at least 4 of the 7 days before data collection were taken from medication administration records and coded for analysis. IPM designation was based on modification of a list developed by Beers et al. and currently used by nursing home surveyors.

RESULTS: The majority of RC/AL patients were taking five or more medications; 16.0% of these patients were receiving IPMs. The most common IPMs were oxybutynin, propoxyphene, diphenhydramine, ticlopidine, doxepin, and dipyridamole. In multivariate analyses, using generalized estimating equations, IPM use was associated with the number of medications received, smaller facility bed size, moderate licensed practical nurse turnover, absence of dementia, low monthly fees, and absence of weekly physician visits.

CONCLUSIONS: IPMs remain a problem in long-term care, but rates in these RC/AL settings compare favorably with those reported for other frail older populations, suggesting that use of medications with severe adverse effects may be waning. Regular physician facility visits may improve prescribing, as will attention to high-risk groups such as individuals on multiple medications. **J Am Geriatr Soc 50:1001–1011, 2002.**

Key words: medications; assisted living; long-term care

Adverse drug events are the most common medical error occurring in the United States today.[1] Although older persons represent less than one-fifth of the U.S. population, they use more than one-third of all prescription medications dispensed.[2] As many as 18% of all outpatient visits involve drug complications,[3] which are implicated in 6% to 21% of older outpatient visits.[4,5] Between 18% and 24% of admissions of hospitalized older patients are attributable to adverse drug events.[6,7] Persons aged 65 and older are particularly susceptible to adverse drug events because of high rates of medication use and physiological changes associated with aging. These factors are accentuated in long-term care facilities, where polypharmacy is common and the reported rates of adverse drug events are as high as 67% to 74%.[8,9]

Medication selection is an important factor influencing the likelihood of adverse drug events. Advances in therapeutics require that physicians update their prescribing practices when safer, superior alternatives to existing products become available. In addition, changes in patient medical status over time can cause medications that have been used chronically to become unsafe or ineffective. In clinical practice, drug selection involves a variety of biomedical and psychosocial factors. For example, because of the limited finances of many geriatric patients, physicians often choose

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older, less-expensive medications rather than newer, more-targeted alternatives.[10] Thus, medication prescribing involves a process whereby the physician considers multiple possible agents and selects one based on the individual patient's needs, medical status, and available resources.

Nevertheless, certain medications are rarely if ever indicated for older persons, because they are ineffective or because safer, effective alternatives exist. For example, alpha-methyldopa and reserpine were once acceptable antihypertensives, but newer agents have supplanted them. In the early 1990s, the term *inappropriate medications* was introduced by Beers et al. to describe such drugs whose use in older persons was no longer recommended.[11,12] In 1999, the Health Care Financing Administration (HCFA) incorporated a modification of this "potentially inappropriate medication" list into nursing home survey criteria.[13] Investigators have used modifications of the Beers list to report on potentially inappropriate medication use in skilled nursing facilities[14] and by community-dwelling older people[15] and homebound managed care plan participants.[16]

One healthcare sector in which inappropriately prescribed medicine (IPM) use has received little attention is residential care/assisted living (RC/AL). Spore et al. showed that between 20% and 25% of residents in a 10-state sample of board and care homes had at least one inappropriate prescription, raising concern about drug interactions and adverse effects.[17] This is of special concern because the number of RC/AL facilities is growing rapidly; by 2005, it is estimated that more persons will be housed in RC/AL facilities than in nursing homes.[18] Compounding this, RC/AL facilities serve primarily older persons, a population that is typified by multiple disease states, polypharmacy, altered pharmacokinetics, and a high prevalence of drug-related adverse events.[19,20] In addition, the staff in RC/AL facilities who administer medications are generally not nurses, and many have little or no training in medication administration and effects. Finally, compared with nursing homes, RC/AL facilities have less oversight by registered nurses (RNs) and pharmacists.

The analysis reported in this paper was performed to determine the prevalence of IPM use among a representative sample of more than 2,000 RC/AL residents in four states. In this study, the prevalence and distribution of IPMs are described, and resident and facility factors are identified that are associated with receipt of one or more IPMs.

METHODS

Sample

Data reported in this paper were collected as part of the Collaborative Studies of Long-Term Care (CS-LTC), a multistate study of RC/ALs. The study was conducted in four states: Florida, Maryland, New Jersey, and North Carolina. The study states were chosen because each had a well-developed RC/AL industry, and the four represented a range of state regulatory approaches to the development of newer assisted living models. To increase efficiency of data collection, a purposive sample of counties (a sampling region) was selected within each state. Criteria for selection of a sampling region included that it contain at least 15% of the state's residential care facilities, that it contain urban/suburban and rural areas, and that the region fall within 30% of the state mean on eight demographic and health services measures (per capita income; percentage of population aged ≥65, nonwhite, employed, and below poverty level; ratio per 1,000 persons aged ≥65 to primary care physicians, hospital beds, nursing home beds). Across all four states, only one variable deviated from the 30% limit in one state, and examination of that region indicated adequate dispersion of counties over high and low values of that variable.

Within each of the four regions, all licensed RC/AL facilities were identified using state licensure lists. The study definition of RC/AL included any licensed facility, not licensed as a nursing home, that provided room and board, 24-hour supervision, and assistance with activities of daily living. To maximize efficiency in enrolling older subjects, facilities that primarily served persons with mental retardation or developmental disabilities were excluded, as were facilities with fewer than 16 beds that housed fewer than four residents aged 65 and older and facilities with 16 or more beds that housed fewer than 10 residents aged 65 and older.

Eligible facilities were then divided into three strata to adequately sample the range of facility types: small homes (<16 beds); new-model large facilities (≥16 beds; built after January 1, 1987, and fulfilling at least one of the following criteria: at least two different private pay rates, based on resident's service needs; 20% or more of resident population requiring assistance in transfer; 25% or more of resident population incontinent daily; and a registered nurse (RN) or a licensed practical nurse (LPN) on duty around the clock); and traditional large homes (≥16 beds and not meeting the criteria for new-model facilities). One hundred thirteen small facilities, 40 new-model, and 40 traditional facilities were enrolled in the four study states. The facility refusal rate was 41%, but 44 nonrespondents (90% of those selected for sampling) completed a telephone survey, and participating and nonparticipating facilities were found to not differ in age; size; occupancy; or resident age, race, or ethnicity. Nonparticipating RC/AL facilities differed from participating facilities in three of 42 items queried (hours worked by owners, number of rate levels, and resident impairment).

Within each study home, a representative sample of residents was enrolled as follows. In small homes, all residents aged 65 and older were approached for participation. In large facilities, random sampling of residents aged 65 and older was used to achieve target sample sizes (range 17–23 depending on stratum and state). Informed consent was obtained from participating staff and residents; proxies gave written consent for cognitively impaired residents, and the residents were required to assent to in-person data collection. Two thousand seventy-eight RC/AL residents were enrolled: 665 in small facilities, 765 in new model facilities, and 648 in traditional facilities. The subject refusal rate was 8%. The Institutional Review Boards of the University of North Carolina at Chapel Hill and the University of Maryland at Baltimore approved subject enrollment and data collection procedures. Further details of the methods of the Collaborative Studies of Long-Term Care are published elsewhere.[21]

Measures, Data Collection, Coding, and Analysis

On-site interviewers, the majority of whom were RNs, conducted baseline data collection between October 1997

and November 1998. Questionnaires on the structure and process of care were administered to facility staff, and additional facility data were gathered using direct observation. Resident data were gathered using a combination of record review, patient or proxy interview, and direct observation/testing.

Data on the following facility factors were obtained during interviews with facility administrators: bed size, profit/nonprofit status, affiliations with other facilities, the existence of separate levels of care in the same building, services provided, monthly fees, staff hours actually worked in the previous week by nurses (LPNs and RNs) and nursing assistants, and turnover rates of LPNs, RNs, and nursing assistants. Data on the following resident characteristics were gathered by interviews with the residents and the staff caregivers who knew the residents best: age, race, gender, frequency of visits from friends/family, presence of moderate/severe dementia, payment source (e.g., Medicaid), and dependency in six activities of daily living (eating, toileting, transferring, locomotion, dressing and bathing). Moderate or severe dementia was determined to be present if the Mini-Mental State Examination (MMSE)[22] score was below 17, (when the MMSE was not available) if the Minimum Data Set Cognition Scale[23] score was greater than 3, or (in rare cases where neither was available) if a physician or nurse noted one or more of the following diagnoses on the medical record: Alzheimer's disease, senile dementia, senile dementia of the Alzheimer's type, organic brain syndrome, cerebral arteriosclerosis, multiinfarct dementia, subcortical dementia, Binswanger's disease, Pick's disease, Creutzfeldt-Jakob disease, Huntington's disease, Lewy body disease, or dementia.

As part of each subject's on-site data collection, research staff reviewed the Medication Administration Record and wrote down the names of all prescription and nonprescription medications that had been administered to the subject on at least 4 of the previous 7 days. Information on dosage was not gathered. Drug names from the data collection forms were entered verbatim into data entry fields. The resulting data files were cleaned and coded using an existing program to correct misspellings and to code for recognized drugs using the American Hospital Formulary Service system.[24] A pharmacist (LCB) and a geriatrician (PDS) reviewed each remaining uncoded drug to determine what medication was represented and to assign a code. Of the 2,078 RC/AL residents in the study sample, 64 (3.1%) had data containing one or more medications that could not be coded because of illegibility or misspellings. This paper reports on the 2,014 subjects for whom complete medication data were available.

IPMs were coded using an updated version of the list developed by Beers et al.[11,12] (Dr. Beers was consulted about revising the list during the course of our analyses (March 21, 2000); he encouraged revision to reflect changes in pharmacotherapy.) For purposes of these analyses, the following medications were excluded from the Beers list:[12] (1) flecainide, phenylbutazone and cyclandelate were not included because they are no longer marketed; (2) haloperidol and thioridazine were excluded because they may be appropriate for some indications, even though they may cause sedation, extrapyramidal effects, and sedation in some patients; (3) nonsedating antihistamines were excluded because they are considered at times to be appropriate treatment for allergies; (4) oral iron preparations and digoxin were excluded because their prescription's appropriateness on Beer's list depended on dosage and the CS-LTC data did not include drug dosages; (5) short-acting benzodiazepines (oxazepam, triazolam, lorazepam, temazepam, alprazolam, and zolpidem) were excluded because they are widely used for agitation in dementia and for short-term treatment of insomnia in some older people; they have a short half-life, leading to few problems with hangover and accumulation; and dosage was considered in the original criteria; and (6) trazodone was excluded because it is appropriately used in low doses for sedation and agitation. The final list of IPMs used in the study, and recommended alternative medications, is provided as Appendix 1.

Staff of the Cecil G. Sheps Center for Health Services Research Data coded, entered, cleaned, and analyzed data using standard procedures and analytical software packages. To identify factors associated with resident's receiving one or more drugs on the IPM list, associations were studied between facility and resident variables known to affect care provision in long-term care settings. The following facility factors were studied as predictors of IPM use: facility type (small facilities were the reference group), bed size, square of bed size, profit/nonprofit status, nursing home affiliation, whether a physician visited at least weekly, whether nursing services were provided at least weekly, minimum monthly fee, nurse/resident ratio, nursing assistant/resident ratio, RN turnover, LPN turnover, and nursing assistant turnover. The latter six variables were trichotomized into low ($<$25th percentile), moderate (25–75th percentile), and high ($>$75th percentile) and entered into the regression as dummy variables, with the lowest percentile as the reference group. The following resident factors were included in the regression: dementia (moderate or severe), race, gender, age (as four categories), frequency of family/friend visits (moderate = 2–6 days/2 weeks; high = $\geq$7 days/2 weeks), Medicaid or state assistance (yes/no), dependency in activities of daily living (moderate = assistance needed with one or two; heavy = assistance needed with three or more), and number of medications (moderate = 4–8; high = $\geq$9). Bivariate associations were studied using *t* tests (for continuous variables) or chi-square tests (for categorical variables).

To identify the relative contribution of resident and facility factors to the likelihood of a resident receiving one or more IPMs, multivariate regression was performed, using generalized estimating equations to control for the clustering effects of the study sample. Analyses were performed using PROC GENMOD in Statistical Analysis Systems, which accounts for intrafacility correlation while weighting each subject equally.[25] The dichotomous dependent variable was whether a given resident's medication list included one or more IPMs. The regression analysis excluded 29 residents who were on no medications and 64 residents for which one or more medications could not be coded.

RESULTS

Table 1 presents the characteristics of the 193 study facilities and 2,014 subjects used in these analyses. The major-

ity of facilities (58.5%) were small, but the number of subjects was relatively equally divided between the three facility types (31.8% in small, 37.0% in new-model, and 31.1% in traditional). Facility staffing data indicate a dependency on unlicensed staff, with few nursing hours per week (0.6 hours per resident for RNs and 1.2 hours per resident for LPNs). Residents tended to be female, very old (over half were ≥85), and impaired in at least one activity of daily living and to pay privately.

Most study subjects had taken at least one medication on 4 or more of the 7 days before data collection. The mean number of medications taken regularly was 5.1 in small homes, 6.1 in new-model homes, and 5.6 in traditional homes. Few residents were on no medications: 6.0% in small homes, 3.4% in new-model homes, and 4.0% in traditional homes. The most common categories of medications received across all strata were cardiovascular drugs (received overall by 53% of subjects); diuretics/potassium (40%); laxatives/antacids (37%); vitamins/minerals (37%); pain medications such as nonsteroidal anti-inflammatory medications, aspirin, and acetaminophen (28%); and antidepressants (28%).

Three hundred sixty-nine of the 11,649 prescriptions in the sample (3.2%) were IPMs. Across the three types of homes, the percentage of prescriptions that involved IPMs was similar: 3.3% in small homes, 3.2% in new-model homes, and 2.9% in traditional homes. Three hundred twenty-two (16.0%) of the 2,014 study subjects received at least one IPM, ranging from 15.5% in traditional homes to 16.9% in new-model homes (Table 2). The most

Table 1. Descriptive Characteristics of the Study Sample

Characteristics	Number (%)*	Mean ± Standard Deviation
Facility characteristics (n = 193)		
Type of RC/AL facility		
Small†	113 (58.5)	
Traditional	40 (20.7)	
New-model	40 (20.7)	
Bed size		27.9 ± 34.4
Not-for-profit	33 (17.3)	
Affiliated with nursing home	46 (24.7)	
Doctor visits weekly	42 (22.2)	
Nurse present at least weekly	94 (50.0)	
Minimum monthly rate		$1,694 ± 932.8
Staffing ratio (expressed as weekly hours per resident—census at data collection)		
Registered nurses		0.6 ± 1.5
Licensed practical nurses		1.2 ± 2.3
Nursing assistants		9.2 ± 8.8
Turnover (per 6 months: n left/n current FTE)		
Registered nurses		0.3 ± 0.8
Licensed practical nurses		0.3 ± 0.5
Nursing assistants		0.3 ± 0.5
Resident characteristics (n = 2,014)		
Type of RC/AL facility		
Small†	639 (31.7)	
Traditional	630 (31.3)	
New-model	745 (37.0)	
Non white	144 (7.3)	
Male	470 (23.8)	
Age		
75–84	712 (35.9)	
85–89	529 (26.6)	
≥90	502 (25.3)	
Moderate or severe dementia	674 (34.0)	
Family/friend visit ≥once/week	1,228 (62.8)	
On Medicaid or state assistance	254 (13.0)	
ADL dependency		
Number of ADLs dependent		1.6 (1.8)
Dependent in 1 or 2 ADLs	719 (36.2)	
Dependent in ≥3 ADLs	488 (24.6)	
Number of medications ≥4 days/wk		5.8 (2.9)

*Excludes observations that had missing data for specific variables.
†Fewer than 16 beds.
RC/AL = residential care/assisted living; ADL = activities of daily living; FTE = full time equivalent.

common IPMs were oxybutynin, propoxyphene, amitriptyline, ticlopidine, doxepin, and dipyridamole (Table 3).

Table 4 displays the results of the generalized estimating equation regression of facility and resident factors on the probability of having one or more IPMs. The facility factors that were independently associated with an increased probability of a resident being on an IPM included smaller bed size, low minimum monthly fees for residents, moderate LPN turnover, and absence of a weekly physician visit. Resident factors associated with an increased probability of being on an IPM were number of medications received and absence of moderate/severe dementia.

DISCUSSION

The data presented here indicate that polypharmacy is prevalent in RC/AL facilities. The majority of residents in this sample were taking at least five medications, and use of 10 or more medications was not unusual. Furthermore, according to an updated version of Beer's "potentially inappropriate" medication list, 16.0% of study subjects were receiving one or more IPMs, and between 2.9% and 3.3% of RC/AL medications fell into the IPM category. Although these numbers are not unusual for a group of older patients, the normalcy of such numbers should not justify the medication's use.

Strict comparison of these findings with other published studies is not possible for a number of reasons. First, other published studies have used somewhat different criteria for inappropriateness; in this study, modification was made to reflect prescribing practices at the time of the study and to account for the absence of dosage information. Second, the potential for secular trends to influence results exists because of differences in the dates of data collection across studies. Finally, the extent to which nonprescription drugs were included in published studies is unclear, but the rate of potentially inappropriate medication use from this study appears lower than that previously reported in board and care homes[17] and in homebound older people,[16,26] suggesting that use of these medications is decreasing or that the RC/AL facilities surveyed expose their residents less frequently to these drugs. Thus, when analyses are adjusted to remove medications not included in this study's list, the findings of Golden et al.[16] showed that 8% of prescriptions used by homebound older people were inappropriate, of Beers et al.[14] that 4.9% of nursing home prescriptions were inappropriate; and of Wilcox et al.[15] that 23.5% of community-dwelling older people received a potentially inappropriate drug. Although any generalization based on these results must be made with caution, these findings are reassuring in that they suggest that RC/AL settings do not have higher rates than other settings, in spite of employing fewer nurses.

As with all studies of medication use in long-term care, potential sources of error exist. One is the potential that over-the-counter, complementary/alternative, and other medications were brought in by families and administered to residents without being recorded on the medication administration record. No estimate of the extent of this missing data is available, but data collectors who interviewed residents as part of the study did not feel that this constituted a problem. Another source of missing data is the 3.1% of medication that could not be coded because of illegibility or misspellings; this is higher than the 1.6% rate of missing data reported by Hanlon et al. in a community study.[26] In addition, this study assessed appropriateness in terms of efficacy only, because data on indication, dose, duration, comorbid diseases, and potential interactions with other medications were not collected. Thus, this study likely underestimated the presence of "inappropriate" medications in RC/AL facilities. Finally, the cross-sectional design limits the ability to derive causal inferences.

Can further reductions be achieved? Multivariate analyses to identify facility and resident factors associated with IPMs provide insight into potential intervention targets. As noted in Table 4, the strongest predictor of IPM use is the number of medications a patient receives. This finding is intuitive, but it emphasizes that quality monitoring efforts should concentrate on patients with the longest medication lists. The finding that frequent physician visits were associated with fewer inappropriate prescriptions suggests that quality may be improved by encouraging stronger linkages between RC/AL facilities and physicians who make regular visits. The association between moderate LPN turnover and high levels of inappropriate prescriptions suggests that minimal levels of nursing oversight may be inadequate, but the lack of a consistent association between other nursing turnover, or of nurse staffing levels, and inappropriate medication use suggests the need for further research in this area. Finally, increased oversight by consultant pharmacists, although not assessed in this study, may be able to further reduce IPMs. In nursing homes, consultant pharmacists review medications monthly, but for RC/AL facilities the timing and extent of pharmacy review varies and is generally less frequent.

Table 2. Frequency and Number of Inappropriately Prescribed Medications (IPMs), by Facility Type

Characteristic	All RC/AL Facilities (n = 193)	<16 Beds (n = 113)	≥16 Beds	
			Traditional (n = 40)	New-Model (n = 40)
Residents in sample, n	2,014	641	627	746
Prescriptions in sample, n	11,649	3,390	3,635	4,624
Residents with one or more IPMs, n (%)	322 (16.0)	102 (15.9)	97 (15.5)	123 (16.9)
Prescriptions involving IPMs, n (%)	369 (3.2)	113 (3.3)	107 (2.9)	149 (3.2)

RC/AL = residential care/assisted living.

Table 3. Number of Study Subjects (N = 2,014) Regularly Receiving Each Inappropriately Prescribed Medication (IPM), by Facility Type

Medication	All RC/AL Facilities	<16 Beds	≥16 Beds	
			Traditional	New-Model
Oxybutynin	62	15	24	23
Propoxyphene	56	13	15	28
Amitriptyline	45	13	14	18
Diphenhydramine	26	8	9	9
Ticlopidine	26	7	6	13
Doxepin	25	7	11	7
Dipyridamole	19	2	4	13
Hyoscyamine	16	6	2	8
Diazepam	12	7	0	5
Dicyclomine	11	4	2	5
Imipramine	11	6	3	2
Chlordiazepoxide	9	4	3	2
Cyproheptadine	9	5	3	1
Methyldopa	8	2	4	2
Disopyramide	5	2	2	1
Clemastine	3	1	1	1
Cyclobenzaprine	3	3	0	0
Ergot derivatives	3	2	0	1
Flurazepam	3	0	2	1
Carisoprodol	2	1	0	1
Chlorpheniramine	2	1	0	1
Indomethacin	2	0	0	2
Metaxalone	2	1	0	1
Trimethobenzamide	2	0	1	1
Astemizole	1	0	0	1
Azatadine	1	1	0	0
Flavoxate	1	0	0	1
Methadone	1	0	1	0
Papaverine	1	0	0	1
Pentazocine	1	1	0	0
Propanthaline	1	1	0	0

Note: The following medications on the "potentially inappropriate" list were not received by any study subjects: belladonna, buprenorphine, butorphanol, chlorpropamide, chlorzoxazone, dezocine, isoxsuprine, meperidine, meprobamate, methocarbamol, minoxidil, nalbuphine, and reserpine.
RC/AL = residential care / assisted living.

Table 4. Facility and Resident Factors Influencing Likelihood of a Residential Care/Assisted Living Resident Having One or More Inappropriately Prescribed Medications

Factor	Adjusted Odds Ratio*	95% Confidence Limits	
		Lower	Upper
Intercept	0.169	0.087	0.331
Facility-level variables			
Bed size	0.981	0.964	0.998
Square of bed size	1.000	1.000	1.000
Not-for-profit	1.174	0.783	1.760
Affiliated with nursing home	1.134	0.745	1.726
Doctor visit weekly	0.619	0.441	0.868
Nursing weekly	1.255	0.876	1.798
Minimum monthly rate			
Moderate	0.873	0.580	1.313
High	0.437	0.253	0.755
Staffing ratios			
Moderate RN/LPN	1.035	0.658	1.629
Heavy RN/LPN	0.813	0.493	1.339
Moderate PCA	0.767	0.534	1.100
Heavy PCA	0.837	0.542	1.293
Turnover			
Moderate RN	0.435	0.184	1.029
Heavy RN	0.757	0.489	1.172
Moderate LPN	1.711	1.092	2.679
Heavy LPN	1.025	0.623	1.687
Moderate PCA	0.722	0.486	1.074
Heavy PCA	1.203	0.785	1.843
Facility type (stratum)			
Traditional	1.120	0.605	2.072
New-model	1.904	0.987	3.670
Resident-level variables			
Moderate or severe dementia	0.655	0.463	0.926
Nonwhite	0.655	0.363	1.183
Male	0.939	0.674	1.308
Age			
75–84	1.048	0.695	1.579
85–89	0.748	0.490	1.140
≥90	0.929	0.604	1.430
Moderate family/friend visitation	0.890	0.661	1.199
Frequent family/friend visitation	0.777	0.515	1.173
Medicaid or state assistance	0.939	0.616	1.430
ADL dependency			
Moderate	1.281	0.925	1.774
Heavy	1.454	0.971	2.177
Number of regular medications			
4–8	1.984	1.326	2.970
≥9	5.439	3.435	8.612

Note: Analysis was performed using Generalized Estimating Equations (GEE).
*Odds ratios are adjusted for all other variables in the model. The scale parameter for GEE was computed as the square root of the normalized Pearson's chi-square.
RN= registered nurse; LPN = licensed practical nurse; PCA = patient care assistant; ADL = activities of daily living.

Other associations noted in the multivariate analyses are more difficult to interpret. Facility size and monthly fee may have indirect effects as proxies for resources such as nursing oversight. The fact that increases in the minimum monthly fee are associated with parallel decreases in the likelihood of IPMs suggests that some kind of socioeconomic effect is present, a finding that was also identified by Wilcox et al.[15] The finding of an independent relationship between dementia and absence of IPMs is puzzling; perhaps it arose because some common IPMs are used to treat conditions or symptoms rarely voiced by persons with dementia. For example, this may be true of propoxyphene because persons with dementia tend to request and receive fewer pain medications than persons with similar conditions who are cognitively intact.[27,28]

The extent to which these "potentially inappropriate" medications result in adverse resident outcomes is unknown. In the CS-LTC study, observations of patient somnolence at a standard time in the midafternoon were not correlated with IPM use ($\chi^2 = 1.35$, $P = .24$). Other potential outcomes, such as hospitalization, morbidity, mor-

tality, and disability will be studied in a longitudinal follow-up of the cohort, but, given the distribution of the use of individual medications in the study (Table 3), it is unlikely that this list constitutes a strong predictor of adverse health outcomes.

Physicians' prescribing patterns are changing, and many of yesterday's "inappropriate" medications (those with the most severe adverse drug events) have been eliminated from practice through manufacturer's withdrawal, regulatory efforts, or voluntary changes in physician prescribing. In addition, the pharmaceutical industry has responded in some cases to toxic drug effects by reformulating their products. For example, one of the most frequently used "inappropriate" medications on this study's list is oxybutynin. Since the time of data collection, oxybutynin has been reformulated as a sustained-release product, with evidence of reduced adverse effects.[29,30]

Given the possibility that the most clearly "inappropriate" medications are prescribed less frequently, regulatory efforts may need to refocus, as is expected when a quality improvement effort is successful.[31] Thus, facility medical directors, consultant pharmacists, and HCFA surveyors may achieve little clinical improvement by trying to eliminate medications whose appropriateness depends on dose, duration, or indication. Instead, a broader examination of medication use may be needed and other indicators of prescribing problems sought. Measures that may be helpful include patient-adjusted doses (to account for patient factors, such as weight and renal function); frequency of administration; presence of pharmacotherapy without indication; the presence of possible adverse effects; and use of over-the-counter medications, social drugs (e.g., alcohol), and complementary/alternative therapies. In addition, underprescribing may be emerging as a significant problem as more therapeutic options are available for a variety of chronic conditions. The most critical issues in pharmacotherapeutics in long-term care change over time, and monitoring efforts must account for these changes.

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Appendix 1. Potentially Inappropriately Prescribed Medications Studied and Possible Alternative Treatments

Medication	Class/Action	Indications	Rationale for "Inappropriate" Label	Refs	Possible Alternatives
Platelet aggregation inhibitors					
Ticlopidine (Ticlid)	Antiplatelet agent/ platelet aggregation inhibitor	Stroke prevention	Risk of thrombotic thrombocytopenic purpura, neutropenia, agranulocytosis. Should be reserved for patients with aspirin allergy or those who have failed aspirin therapy.	32–36	Aspirin, clopidogrel, aspirin/ dipyridamole
Dipyridamole (Persantine)	Antiplatelet agent/ vasodilating agent	Prevention of thrombosis; maintains patency after surgical grafting; decrease of thrombosis after valve replacement	Efficacy is questionable; low-dose aspirin has known efficacy and should be used instead.	35,36	Aspirin, clopidogrel, aspirin/ dipyridamole
Analgesics					
Meperidine (Demerol)	Opiate agonist	Moderate to severe pain; adjunct to anesthesia and preoperative sedation	More anticholinergic activity than other opiates; nor-meperidine (an active metabolite) accumulates in older patients.	37–39	Other opiate analgesics, tramadol
Propoxyphene (Darvocet, Darvon)	Opiate agonist	Mild to moderate pain	No better than NSAIDs for pain and can cause central nervous system adverse effects (dizziness, confusion), which may lead to hip fractures.	38–40	Ibuprofen, acetaminophen, tramadol
Methadone (Dolophine)	Opiate agonist	Severe pain; narcotic detoxification maintenance programs	Toxic metabolite may accumulate in older patients.	38,39	Other opiate analgesics, tramadol
Pentazocine (Talwin) Buprenorphine (Buprenex) Nalbuphine (Nubain) Butorphanol (Stadol)	Opiate agonist/ antagonist	Moderate to severe pain	Mixed agonist/antagonist agents should be avoided in older people. Pentazocine leads to confusion and sedation; more effective alternatives exist.	38,41	Oxycodone, tramadol
Nonsteroidal antiinflammatory drugs					
Indomethacin (Indocin, Indocin SR)	NSAID	Inflammatory diseases; rheumatic disorders; moderate pain; acute gouty arthritis	May cause sodium/water retention, which may lead to frontal headaches; may cause renal failure; interferes with antihypertensive effect of beta-blockers; risk of psychosis in dementia patients.	42–46	Pain: ibuprofen, acetaminophen Gout: colchicine, less-toxic NSAIDS

(*continued*)

Appendix 1 (Continued)

Medication	Class /Action	Indications	Rationale for "Inappropriate" Label	Refs	Possible Alternatives
Sedative-hypnotics					
Flurazepam (Dalmane) Chlordiazepoxide (Librium, Limbitrol, Librax) Diazepam (Valium)	Long-acting benzodiazepine; hypnotic; sedative	Short-term (7–10 days) treatment of insomnia; anxiety	Use of agents with long half-lives leads to excessive sedation, cognitive impairment, and increased risk of hip fractures.	47–52	Lorazepam, alprazolam at low doses for 7–10 days; buspirone; zolpidem; sleep hygiene; stimulus control; relaxation techniques; education; sleep restriction; psychotherapy
Meprobamate (Miltown, Equanil)	Anxiolytic agent	Anxiety	Highly addictive and sedating.	51,52	Lorazepam, alprazolam at low doses for 7–10 days; buspirone
Antidepressants					
Amitriptyline (Elavil, Limbitrol, Triavil)	Tricyclic antidepressant	Depression; chronic and neuropathic pain; migraine prophylaxis	Pronounced anticholinergic activity; delirium, sedation, postural hypotension can lead to hip fractures.	52–54	Nortriptyline, desipramine; sertraline; buspirone; St. John's Wort; phototherapy
Doxepin (Sinequan)	Tricyclic antidepressant	Depression, anxiety	Strong anticholinergic properties.	52–54	Nortriptyline, desipramine; sertraline; buspirone; St. John's Wort; phototherapy
Antiarrhythmic agents					
Disopyramide (Norpace)	Class IA antiarrhythmic agent	Suppression and prevention of ventricular complexes and tachycardia; conversion and prevention of recurrence of atrial fibrillation, flutter, paroxysmal atrial tachycardia	Potent negative inotrope; may induce heart failure in older people; strong anticholinergic adverse events, particularly in older people; risk of proarrhythmias.	55,56	Other antiarrhythmic agents: amiodarone, sotalol
Oral hypoglycemics					
Chlorpropamide (Diabinese)	Sulfonylurea	Type 2 diabetes mellitus	Long half-life drug, therefore more likely to cause hypoglycemia; half-life prolonged further by renal dysfunction; may cause hyponatremia, syndrome of inappropriate antidiuretic hormone secretion.	57–59	Metformin, acarbose, other sulfonylureas

(*continued*)

Appendix 1 (Continued)

Medication	Class /Action	Indications	Rationale for "Inappropriate" Label	Refs	Possible Alternatives
Gastrointestinal antispasmodics					
Dicyclomine (Bentyl) Hyoscyamine (Levsin, Levsinex) Propantheline (Pro-Banthine) Belladonna alkaloids (Donnatal, etc)	Gastrointestinal antispasmodic agent; antimuscarinic	Irritable bowel syndrome; functional disturbances of gastrointestinal motility; urinary incontinence	Potential for toxic reactions greater than potential for benefit; avoid long-term use; highly anticholinergic.	29,30, 60,61	Biofeedback; relaxation training; cognitive behavior therapy; tolterodine, extended-release oxybutynin
Oxybutynin (Ditropan)	Urinary antispasmodic agent	Urgency, frequency, urge incontinence; uninhibited bladder	Not effective for incontinence and detrusor instability in institutionalized older people; highly anticholinergic.	29,30, 61–64	Tolterodine, pelvic muscle exercise, bladder retraining, biofeedback, functional electrical stimulation, extended-release oxybutynin
Antiemetics					
Trimethobenzamide (Tigan)	Antiemetic	Nausea, vomiting	May cause extrapyramidal adverse events; least effective antiemetic agent.	65,66	Prochlorperazine, ondansetron, smaller and more frequent meals
Muscle relaxants/antispasmodics					
Methocarbamol (Robaxin) Carisoprodol (Soma) Metaxalone (Skelaxin) Cyclobenzaprine (Flexeril) Chlorzoxazone (Paraflex)	Skeletal muscle relaxant	Muscle spasm and pain	Potential for toxic reactions greater than potential for benefit; highly anticholinergic; sedating; may cause weakness.	67,68	Baclofen, nonpharmacological techniques
Antihypertensives					
Reserpine (Serpasil, Hydropres)	Antihypertensive (Rauwolfia alkaloid)	Mild to moderate hypertension	May cause depression, sedation in older people; can aggravate peptic ulcers.	69,70	Use diuretics first, then calcium channel blockers or angiotensin converting enzyme inhibitors
Methyldopa (Aldomet, Aldoril)	Alpha-adrenergic inhibitor; antihypertensive	Moderate to severe hypertension	Therapeutically ineffective.	71	Use diuretics first, then calcium channel blockers or angiotensin converting enzyme inhibitors
Dementia treatments					
Ergot mesyloids (Hydergine)	Ergot alkaloids	Cerebrovascular insufficiency in dementia; Alzheimer's disease; senile onset	Therapeutically ineffective; extrapyramidal adverse events: tardive dyskinesia.	72–75	Donepezil, risperidone, rivastigmine, galantamine

NSAID = nonsteroidal antiinflammatory drug.