Research and Reports

Identification of Elderly Nursing Facility Residents at High Risk for Drug-Related Problems

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Objective: To identify potential risk factors for drug-related problems in elderly nursing facility residents, and to examine the prevalence of these risk factors in three diverse nursing facility populations.

Design: Survey and retrospective review of medical records.

Setting: Three North Carolina nursing facilities.

Interventions: A literature search was conducted to identify potential risk factors. A two-round survey of 15 health care professionals with expertise in geriatrics established consensus by rating the potential risk factors with a five-point Likert scale.

Main Outcomes: List of potential risk factors for drug-related problems; prevalence of potential risk factors in nursing facility residents.

Results: Thirty-three potential risk factors for drug-related problems in elderly nursing facility residents were identified. The expert panel agreed upon 18 selected risk factors. The most prevalent medications/ medication classes identified as risk factors were: (1) anticholinergics, (2) narcotic analgesics, and (3) digoxin. The most prevalent patient characteristics identified as risk factors were: (1) six or more chronic active medical diagnoses, (2) decreased renal function (estimated creatinine clearance < 50 ml/ min), and (3) low body mass index (< 22 kg/m^2). Nearly 68% of the elderly nursing facility residents examined had four or more risk factors.

Conclusion: A consensus survey of experts can adequately identify potential risk factors that may place elderly nursing facility residents at high risk for drug-related problems, and these risk factors are prevalent.

Key Words: Drug-related problems, Risk factors, Elderly, Nursing facility, Prevalence.

Abbreviations Used: CI = confidence interval; LTCF = long-term care facility.

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Medications play an important role in the cure, palliation, and prevention of disease. Although medications provide benefit, they also expose patients to drug-related problems. Geriatric individuals are frequent consumers of medications due to the high prevalence of chronic disease. The elderly may be at particular risk for drug-related problems due to physiologic changes that occur with aging, multiple concomitant diseases, and a loss of homeostatic reserve.[1]

Drug-related problems can be defined as "an undesirable patient experience that involves drug therapy and that actually or potentially interferes with a desired patient outcome."[2] Drug-related problems may include under-prescribing, improper drug selection, overdosage, adverse drug reactions, drug interactions, and drug use without indication.[2] Undesired patient outcomes in the elderly may include hospitalization, falls, functional decline, and changes in cognition.

It would be useful for consultant pharmacists to have information to help identify patients at high risk for drug-related problems. It may be beneficial to target these patients for more intensive pharmacy services. However, there is limited data about the prevalence of drug-related problems in nursing facility residents, or the factors that increase the risk of such events in this population. Cooper et al. reported the occurrence of drug-related problems in 102 residents at a 72-bed facility over a 24-month period.[3] A total of 1,224 drug-related problems were detected, with the rank order being: (1) medication administration/documentation error, 26.5%; (2) relative contraindication to drug use, 16.5%; (3) adverse drug reaction or interaction, 13.1%; (4) questionable efficacy, 3.8%; (5) treatment need by history but none ordered, 3.8%; and (6) miscellaneous other reasons, 36.3%. Few investigators have formally explored the relationship between sub-optimal prescribing and health-related outcomes in institutionalized patients.[4] In a study by Beers et al. of 1,106 nursing facility residents in Southern California, the prevalence of inappropriate medication use defined by explicit criteria was 40%.[5] There is also limited information about adverse drug reactions in elderly nursing facility residents.[6-9] Gurwitz et al. reported 180 medication-related events in a 703-bed, academically-oriented long-term care facility over the course of one year through the evaluation of resident incident reports.[9] Reports of errors in dosing and administration were more common than reports of adverse drug reactions (72.2% versus

27.8%).

Given the paucity of data regarding identification of elderly nursing facility residents at high risk for drug-related problems, the objectives of this study were twofold. The first was to develop a list of potential risk factors to identify elderly nursing facility residents at high risk for drug-related problems. The second objective was to determine the prevalence of these risk factors in elderly nursing facility residents in actual practice settings.

Methods

Development of Survey

An extensive literature search was conducted using MEDLINE, International Pharmaceutical Abstracts, and Current Contents databases to identify articles and abstracts from the scientific literature, published from 1966 through November 1996 in English, on the topics of drug-related problems, suboptimal prescribing, and adverse drug reactions occurring in elderly nursing facility residents or community-dwelling elderly. Also examined were reference lists from identified articles, recent reviews, and textbooks to identify additional articles. A total of 36 articles were identified.[3,6,7,9-42]

These articles were reviewed for relevancy by two of the authors, Fouts and Hanlon, who compiled a preliminary list of potential risk factors. A final list of potential risk factors was prepared after a meeting of the clinical investigative team: Fouts, Hanlon, Perfetto, and Feinberg. Table 1 lists these 30 potential risk factors for drug-related problems.

Table 1. Potential Risk Factors Identified via the Literature, Investigative Team, and Expert Panel

Specific Medication

- Digoxin
- Warfarin
- Lithium
- Theophylline
- Chlorpropamide
- Glyburide

Patient Characteristics

- Number of active chronic medical diagnoses (> 6)
- Number of doses of medication per day (> 12)
- Recent transfer from hospital
- Advanced age (> 85 years)

- Prior adverse drug reaction
- Cancer
- Depression
- Low body weight or body mass index (< 22 kg/m2)
- Six or more medications
- Nine or more medications
- Cognitive impairment including dementia*
- Decreased renal function (estimated creatinine clearance < 50 ml/min)*

Class of Medication

- Anticonvulsants
- Antiarrhythmics
- Antipsychotics
- Antidepressants
- Sedative/hypnotics
- Benzodiazepine-long-acting (half-life > 24 hours)
- Benzodiazepine-intermediate-acting (half-life 10-24 hours)
- Benzodiazepine-short-acting (half-life < 10 hours)
- Histamine$_2$-antagonists
- Nonsteroidal anti-inflammatory agents
- Anticholinergics*
- Angiotensin converting enzyme inhibitors
- Diuretics
- New prescription for antibiotic
- Narcotic analgesics

* Added after first round of survey at suggestion of expert panel.

Expert Panel and Survey

The list of potential risk factors was sent out to a multidisciplinary panel consisting of 28 physicians, nurses, and pharmacists-selected based on their work in the field of geriatrics, and more specifically, long-term care. The survey methods used were based, in part, on those used in previous studies that defined certain aspects of drug-related problems.[12, 26, 43] To reach consensus on the proposed risk factors, a two-round, written survey based on the Delphi process of providing feedback information on the responses of the group was used.[44] The panel members were asked to rate on a five-point Likert scale (1 = definitely not a risk factor; 5 = definitely a risk factor; and the midpoint, 3 as equivocal) the likelihood that each of the listed factors independently contributed to placing an elderly nursing facility resident at risk for experiencing a drug-related problem. The panel was also given the opportunity to rate the two most important and least important risk factors, and to provide additional risk factors.

The response rate was 71% overall (Appendix 1). In order to maintain equal representation among disciplines, five members were randomly selected from each of three groups of respondents (medicine, nursing, pharmacy). Those potential risk factors identified as probably or definitely not a risk factor as indicated by a mean score less than 5.0 and an upper confidence interval (CI) less than 4.0 were rejected. Risk factors identified as definitely or probably a risk factor, as defined by a mean score of 4.0 or greater with a lower 95% CI greater than or equal to 4.0 on the first round survey were accepted. New additional risk factors listed by two or more panel members were added to the second-round survey. Risk factors identified as equivocal, defined as a mean score of 4.0 or greater with a lower 95% CI less than 4.0, on the first-round survey were also included in the second-round survey.

The second-round survey was sent to each of the 15 panel members to clarify consensus on equivocal risk factors and to solicit input on the new items added by the panel members in the first-round. The response rate for the second-round survey was 100%. The second-round survey provided each panel member with the mean group response as well as their own initial response as appropriate. The same criteria for inclusion were applied to the results of the second round survey. Only those factors at either the first or second survey whose 95% CI was greater than or equal to 4.0 were retained indefinitely.

Prevalence

Following completion of the survey process, a final list of risk factors for drug-related problems in elderly nursing facility residents was compiled. One investigator, Fouts, applied the criteria cross-sectionally to three diverse nursing facility populations in North Carolina to determine prevalence. The criteria were applied to all residents of the nursing facilities who were physically present during the month of March, 1997 during site visits, who had been residents for longer than one month, and who were 65 years of age or older. Residents were excluded if they were temporarily placed in the facility for the purpose of respite care, independent care during completion of oncologic therapy, or short-term rehabilitation. The presence of specific risk factors as well as the number of risk factors per resident was extracted from the medical chart. Medication/medication class risk factors were counted if the patient had received the medication during the previous month. Therefore, "as needed" medications were not included if they had not been used. With the exception of anticholinergics, the implicated medications were categorized into major therapeutic classes according to the Veterans Affairs Medication Classification System.[45] For anticholinergics drugs, we specifically used the article by Peters to categorize them.[46]

Analysis

Distributional properties of the survey data were summarized by use of basic descriptive statistics (e.g., means and 95% CIs) for the ratings for each factor. Descriptive statistics (e.g., proportion) also were used to summarize the prevalence of risk factors in the application phase of the project. SAS programs were used to conduct the analyses.[47]

Results

During the first survey round, the expert panel eliminated six potential risk factors (angiotensin converting enzyme *inhibitors*, diuretics, cancer, depression, H_2 antagonists, and new prescription for antibiotic) and accepted 11 factors (nine or more medications, six or more medications, long-acting benzodiazepines, intermediate-acting benzodiazepines, sedative/hypnotics, antipsychotics, warfarin, low body weight or body mass index, narcotic analgesics, chlorpropamide, and lithium) via consensus (see Tables 2 and 3). However, "six or more medications" was dropped due to its similarity with the factor "nine or more medications"; the least restrictive of these was retained. Three additional risk factors were added by the expert panel (anticholinergics, cognitive impairment including dementia, and decreased renal function). Additionally, the remaining 13 risk factors (number of active chronic medical diagnoses, digoxin, short-acting benzodiazepines, anticonvulsants, advanced age, prior adverse drug reaction, theophylline, antiarrhythmics, nonsteroidal anti-inflammatory agents, recent transfer from hospital, number of doses of medication per day, antidepressants, and glyburide) went back for resurvey due to inconclusive results as defined above.

Table 2. Potential Risk Factors for Drug-Related Problems Rejected from Final Survey Consensus List and Scores

Potential Risk Factors	Mean	95% CI
Specific Medications		
Glyburide	3.9	3.5-4.2
Theophylline	4.3	3.9-4.6
Class of Medication		
Antiarrhythmics	4.1	3.8-4.5
Angiotensin converting enzyme inhibitors	3.4	3.1-3.7
Antidepressants	3.7	3.4-4.1
Diuretics	3.7	3.4-3.9
Histamine2-antagonists	3.1	2.7-3.6
New prescription for antibiotics	3.0	2.7-3.3
Nonsteroidal anti-inflammatory agents	4.1	3.8-4.3
Benzodiazepines-short acting (half-life < 10 hours)	3.9	3.6-4.2
Patient Characteristics		
Cancer	3.4	2.9-3.9
Cognitive impairment	4.1	3.8-4.5
Depression	3.4	3.1-3.7

Recent transfer from hospital	4.2	3.8-4.6
Six or more medications*	4.5	4.2-4.9

*Dropped, due to overlap with "nine or more medications" criteria.
CI = Confidence Interval

The second round survey further eliminated eight potential risk factors (theophylline, antiarrhythmics, nonsteroidal anti-inflammatory agents, recent transfer from hospital, antidepressants, glyburide, short-acting benzodiazepines, and cognitive impairment; See Table 2). Moreover, the expert panel accepted the remaining eight potential risk factors (number of active chronic medical diagnoses, digoxin, anticonvulsants, advanced age, prior adverse drug reaction, number of doses of medication per day, decreased renal function, and anticholinergics). The final list of 18 potential risk factors, their mean scores, and 95% CI are listed in Table 3.

Table 3. Final Survey Consensus List and Scores for Potential Risk Factors for Drug-Related Problems in Elderly Nursing Facility Residents

Factors	**Mean**	**95% CI**
Specific Medications		
Digoxin	4.3	4.0-4.6
Warfarin	4.7	4.4-4.9
Lithium	4.5	4.2-4.8
Chlorpropamide	4.5	4.1-4.8
Class of Medication		
Anticonvulsants	4.3	4.0-4.7
Antipsychotics	4.7	4.4-5.0
Sedative/hypnotics	4.7	4.5-5.0
Benzodiazepine-long-acting (half-life > 24 hours)	4.8	4.6-5.0
Benzodiazepine-intermediate-acting (half-life 10-24 hours)	4.3	4.1-4.6
Narcotic analgesics	4.5	4.3-4.8
Anticholinergics	4.4	4.0-4.8
Patient Characteristics		
Number of active chronic medical diagnoses (> 6)	4.3	4.0-4.6
Number of doses of medication per day (> 12)	4.7	4.5-5.0
Nine or more medications	5.0	5.0-5.0
Prior adverse drug reaction	4.4	4.1-4.7

Low body weight or body mass index (< 22 kg/m2)	4.7	4.4-4.9
Advanced age (> 85)	4.5	4.2-4.7
Decreased renal function (< 50 ml/min)	4.5	4.1-4.8

CI= Confidence interval

The final list of potential risk factors for drug-related problems was applied cross-sectionally to three diverse nursing facility populations in North Carolina. Facility A consisted of 24 long-term care facility (LTCF) beds located in a continuing care community (age range 71-100, 100% white, 62% female). Facility B consisted of 84 LTCF beds located in a Department of Veterans Affairs nursing facility (age range 65-100, 73.8% white, 8.3% female). Facility C consisted of 144 LTCF beds located in a for-profit community nursing facility (age range 65-100, 75.7% white, 72.2% female).

Table 4 summarizes the prevalence of individual risk factors by nursing facility. The rates are comparable across the different nursing facility populations. The most common medications/ medication class risk factors for drug-related problems were, in rank order: (1) anticholinergics, (2) narcotic analgesics, (3) digoxin, (4) intermediate-acting benzodiazepines, and (5) antipsychotics. The most common patient characteristic risk factors for drug-related problems were, in rank order: (1) six or more chronic active medical diagnoses, (2) decreased renal function (estimated creatinine clearance < 50 ml/ min), (3) low body weight (body mass index < 22 kg/m2), (4) prior history of an adverse drug reaction, and (5) advanced age.

Table 4. Prevalence of Potential Risk Factors for Drug-related Problems in Elderly Nursing Facility Residents by Facility and Combined

Risk Factors	Facility A n (%)	Facility B n (%)	Facility C n (%)	Combined n (%)
Specific Medications				
Digoxin	8 (33.3)	6 (7.1)	29 (20.1)	43 (17.1)
Warfarin	0	5 (6.0)	10 (6.9)	15 (6.0)
Lithium	0	4 (4.8)	2 (1.4)	6 (2.4)
Chlorpropamide	0	0	0	0 (0)
Class of Medication				
Anticholinergics	7 (29.2)	21 (25.0)	64 (44.4)	92 (36.5)
Narcotic analgesics	7 (29.2)	13 (15.5)	29 (20.1)	49 (19.4)
Benzodiazepines- intermediate-acting	3 (12.5)	6 (7.1)	20 (13.9)	29 (11.5)
Antipsychotics	2(8.3)	15 (17.9)	11 (7.6)	28 (11.1)
Anticonvulsants	1 (4.2)	11 (13.1)	15 (10.4)	27 (10.7)

Benzodiazepines-long-acting	1 (4.2)	4 (4.8)	5 (3.5)	10 (4.0)
Sedative/hypnotics	0	1 (1.2)	1 (0.7)	2 (0.8)
Patient Characteristics				
Number of active chronic medical diagnoses (> 6)	17 (70.8)	63 (75.0)	104 (72.2)	184 (73.0)
Decreased renal function	23 (95.8)	43 (51.2)	111 (77.1)	177 (70.2)
Low body weight	8 (33.3)	31 (36.9)	69 (47.9)	108 (42.9)
Prior adverse drug reaction	15 (62.5)	44 (52.4)	47 (32.6)	106 (42.1)
Advanced age (> 85)	20 (83.3)	14 (16.7)	68 (47.2)	102 (40.5)
Number of doses of medication per day (> 12)	5 (20.8)	46 (54.8)	42 (29.2)	93 (36.9)
Nine or more medications	5 (20.8)	29 (34.5)	27 (18.8)	61 (24.2)

The distribution of risk factors among nursing facility residents was also comparable across the different types of nursing facilities (Figure 1). No one was without at least one risk factor. The largest group consisted of those with four risk factors (23.8%). Only 32% of residents had three or fewer potential risk factors (Table 5).

Table 5. Cumulative Frequency of Elderly Nursing Facility Residents with Potential Risk Factors for Drug-Related Problems

Number of Risk Factors Present	Residents (n = 252) n (%)
0	0
<= 1	14 (5.6)
<= 2	38 (15.1)
<= 3	81 (32.1)
<= 4	141 (55.9)
<= 5	178 (70.6)
<= 6	213 (84.5)
<= 7	232 (92.1)
<= 8	242 (96.0)
<= 9	249 (98.8)
<= 10	252 (100.0)

Discussion

Consensus methods were used to identify 11 medication and seven patient characteristic risk factors for drug-related problems in elderly nursing facility populations. It is interesting to note that only four of the 11 medications have a narrow therapeutic index. Moreover, 45% of the medications are psychotropics, and 73% have considerable central nervous system activity. One reason for this might be the well-known propensity of psychotropics to cause adverse effects in the elderly.[3,6,7,12,14,17,21,24,25,27,28,31,34-37]

The prevalence of potential risk factors in the three diverse nursing facility populations was consistent among the nursing facilities. All of the elderly residents had at least one risk factor and more than two-thirds of the residents had four or more risk factors. It would appear that the criteria meet the standards required for content validity.[48] All of the risk factors were present in more than 10% of the sample with the exception of chlorpropamide, sedative/hypnotics (excluding intermediate-acting benzodiazepines), lithium, and warfarin. It is encouraging that these high-risk medications are being avoided in this fragile population, although the low prevalence of warfarin use may represent underutilization.

Anticholinergic drug use was the most prevalent class of high-risk medications. However, prevalence of anticholinergic use in this sample (36%), is lower than the 60% rate previously reported in a nursing home population.[14] This may be explained in part by the inclusion by Blazer et al. of certain psychotropic medications in their definition of anticholinergic medications. Another potential difference in methodology is that Blazer et al. used a Medicaid prescription database that captured anticholinergic use ordered on an "as needed" basis even when the patient had not received the medication during the previous month.

High-risk patient characteristics were more prevalent than medication risk factors (74% versus 26% of total risk factors). One prevalent patient characteristic in our sample was low body weight (42.9%). Low body weight is an important risk factor for overmedication secondary to failure to reduce doses based on body weight.[18] However, issues about dosing guidelines and flexibility in dosage formulations may prohibit consistent application of reduced doses. Additionally, a decline in glomerular filtration rate, prevalence 70.2% in our sample, affects the renal excretion of many potentially toxic medications. The combination of decreased renal excretion and loss of homeostatic reserve may further increase the potential for dose-related toxicity. Considering the prevalence of multiple potential risk factors and the use of high risk medications in this population, failure to adjust doses may lead to drug toxicity.

The prevalence survey revealed that a large number of elderly nursing facility residents are at high risk for drug-related problems. These risk factors could be used to identify residents who may benefit from more intensive pharmacy services, such as prospective review of all medication orders in these selected patients, rather than the current, Medicaid/Medicare Condition of Participation requiring pharmacist-conducted drug regimen reviews that is typically performed retrospectively. Due to the prevalence of risk factors and the potential lack of independence, it would be rational to set a predefined number of risk factors that would trigger this more intensive monitoring.

There are several potential limitations to this study. The prevalence data was collected by a single investigator, therefore, the reliability and validity of the application of the risk factors has not been demonstrated. Moreover, this prevalence data may be an underestimation since information may not always be documented in patient's medical records. It is likely that some of the patient characteristic risk factors are not independent (e.g., advanced age and renal function, or number of drugs and number of diagnoses). However, the sample size was inadequate to perform analysis controlling for these potential correlations. Moreover, some factors may be more clinically important than others, and this is not accounted for in the final list of potential risk factors. Finally, the prevalence survey used a convenience sample of three diverse nursing facility populations in North Carolina, which may limit the ability to generalize our findings.

Despite these potential limitations, we conclude that a consensus survey of experts can adequately identify potential risk factors that may place elderly nursing facility residents at risk for drug-related problems. We have also concluded that these risk factors are prevalent in nursing facilities. Future studies should assess the relationship between identification of residents with these potential risk factors and actual health outcomes.

Appendix I. Potential Risk Factor Survey Respondents

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References

1. Owens NJ, Fretwell MD, Willey C et al. Distinguishing between the fit and frail elderly, and optimizing pharmacotherapy. Drugs & Aging 1994;4:47-55.

2. Strand LM, Morley PC, Cipolle RJ et al. Drug-related problems: their structure and function. DICP Ann Pharmacother 1990;24:1093-7.

3. Cooper JW. Drug-related problems in a geriatric long-term care facility. J Ger Drug Ther 1986;1:47-68.

4. Perfetto EM, Baldwin R, Konrad TR et al. DUR and appropriate drug prescribing: effects on board and care resident outcomes. (abstract) Gerontologist 1993;33(S1):82.

5. Beers MH, Ouslander JG, Fingold SF et al. Inappropriate medication prescribing in skilled nursing facilities. Ann Intern Med 1992;117:684-9.

6. Cooper JW. Probable adverse drug reactions in a rural geriatric nursing home population: a four-year study. J Am Geriatr Soc 1996;44:194-7.

7. Hanlon JT, Schmader K, Lewis I. Adverse drug reactions. In: Delafuente JC, Stewart RB, (eds.). Therapeutics in the Elderly, 2nd ed. Cincinnati: Harvey Whitney Books, 1995;212-27.

8. Monette J, Gurwitz JH, Avorn J. Epidemiology of adverse drug events in the nursing home setting. Drugs & Aging 1995;7:203-11.

9. Gurwitz JH, Sanchez-Cross MT, Eckler MA et al. The epidemiology of adverse and unexpected events in the long-term care setting. J Am Geriatr Soc 1994;42:33-8.

10. Aronow WS. Prevalence of appropriate and inappropriate indications for use of digoxin in older patients at the time of admission to a nursing home. J Am Geriatr Soc 1996;44:588-90.

11. Beers MH, Dang J, Hasegawa J et al. Influence of hospitalization on drug therapy in the elderly. J Am Geriatr Soc 1989; 37:679-83.

12. Beers MH, Ouslander JG, Rollingher I et al. Explicit criteria for determining inappropriate medication use in nursing home residents. Arch Intern Med 1991;151:1825-32.

13. Beers MH. Defining inappropriate medication use in the elderly. Ann Rev Gerontol Geriatr 1992;12:29-40.

14. Blazer II DG, Federspiel CF, Ray WA, Schaffner W. The risk of anticholinergic toxicity in the elderly: a study of prescribing practices in two populations. J Gerontol 1987;38:31-5.

15. Bowen JD, Larson EB. Drug-induced cognitive impairment: defining the problem and finding solutions. Drugs and Aging 1993;3:349-57.

16. Brook RH, Kamberg CJ, Mayer-Oakes A et al. Appropriateness of acute medical care for the elderly: an analysis of the literature. Health Policy 1990;14:225-42.

17. Budden F. Adverse drug reactions in a rural geriatric nursing home population: a four year study. J Am Geriatr Soc 1985; 33:449-50.

18. Campion EW, Avorn J, Reder VA et al. Overmedication of the low-weight elderly. Arch Intern Med 1987;147:945-7.

19. Chrischilles EA, Segar ET, Wallace RB. Self-reported adverse drug reactions and related resource use. A study of community-dwelling persons 65 years of age and older. Ann Intern Med 1992;117:634-40.

20. Cleeland CS, Gonin R, Hatfield AK et al. Pain and its treatment in outpatients with metastatic cancer. N Engl

J Med 1994;330:592-6.

21. Doucet J, Chassagne P, Trivalle C et al. Drug-drug interactions related to hospital admissions in older adults: a prospective study of 1,000 patients. J Am Geriatr Soc 1996;44:944-8.

22. Gerety MB, Cornell JE, Plichta DT et al. Adverse events related to drugs and drug withdrawal in nursing home residents.

J Am Geriatr Soc 1993;41:1326-32.

23. Goldberg RJ, Mor V, Wiemann M et al. Analgesic use in terminal cancer patients: reports from the national hospice study. J Chronic Dis 1986;34:548-56.

24. Hanlon JT, Cutson T, Ruby CM. Drug-related falls in the older adult. Top Geriatr Rehabil 1996;11:38-54.

25. Jue SG, Clark BG, Araki MA. Inservice teaching and adverse drug reactions in a nursing home. DICP 1985;19:483-7.

26. Koecheler JA, Abramowitz PW, Swim SE et al. Indicators for the selection of ambulatory patients who warrant pharmacist monitoring. Am J Hosp Pharm 1989;46:729-32.

27. Larson EB, Kukull WA, Buchner D et al. Adverse drug reactions associated with global cognitive impairment in elderly persons. Ann Intern Med 1987;107:169-73.

28. Monane M, Avorn J, Beers MH et al. Anticholinergic drug use and bowel function in nursing home patients. Arch Intern Med 1993;153:633-8.

29. NIH Consensus Conference. Diagnosis and treatment of depression in late life. JAMA 1992;268:1018-24.

30. Ruthazer R, Lipsitz LA. Antidepressants and falls among elderly people in long-term care. Am J Public Health 1993; 83:746-9.

31. Segal JL, Thompson JF, Floyd RA. Drug utilization and prescribing patterns in a skilled nursing facility: the need for a rational approach to therapeutics. J Am Geriatr Soc 1979;27:117-22.

32. Sherman DS, Avorn J, Campion EW. Cimetidine use in nursing homes: prolonged therapy and excessive doses. J Am Geriatr Soc 1987;35:1023-7.

33. Shorr RI, Griffin MR, Daugherty JR et al. Opioid analgesics and the risk of hip fracture in the elderly: codeine and propoxyphene.

J Gerontol Med Sci 1992;47:M111-15.

34. Soon JA. Developing an adverse drug reaction program in nursing homes. Can J Hosp Pharm 1980;33:158-64.

35. Soon JA. Assessment of an adverse drug reaction monitoring program in nursing homes. Can J Hosp Pharm 1985;38:120-5.

36. Thapa PB, Gideon P, Fought RL et al. Psychotropic drugs and risk of recurrent falls in ambulatory nursing home residents. Am J Epidemiol 1995;142:202-11.

37. Wennmo K, Wennmo C. Drug-related dizziness. Acta Otolaryngol (Stockh) 1988; (Suppl)455:11-13.

38. Avorn J, Gurwitz JH. Drug use in the nursing home. Ann Intern Med 1995;123:195-204.

39. Montamat SC, Cusack B. Overcoming problems with polypharmacy and drug misuse. Clin Ger Med 1992;8:143-158.

40. Stewart RB, Cooper JW. Polypharmacy in the aged: practical solutions. Drugs & Aging 1994;4:449-61.

41. Tobias DE, Pulliam CC. General and psychotherapeutic medication use in 490 nursing facilities: a 1994 national survey. Consult Pharm 1994;9:1427-35.

42. Williams B, Betley C. Inappropriate use of nonpsychotropic medications in nursing home. J Am Geriatr Soc 1995;43:513-19.

43. Samsa G, Hanlon JT, Schmader KE et al. A summated score for the Medication Appropriateness Index: development and assessment of clinimetric properties including content validity. J Clin Epidemiol 1994;47:891-6.

44. Jones J, Hunter D. Consensus methods for medical and health services research. Br Med J 1995;311:376-80.

45. Veterans Affairs Medication Classification System. In: United States Pharmacopeia Dispensing Information (USP DI), 10th ed. Appendix VI. Rockville, MD : USPDI, 1990,2925-60.

46. Peters NL. Snipping the thread of life: antimuscarinic side effects of medications in the elderly. Arch Int Med 1989;149:2414-20.

47. SAS/STAT User's Guide. Cary, NC: SAS Institute, 1993.

48. Feinstein AR. Clinimetrics. New Haven: Yale University Press, 1987:141-211.

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