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Interventions to Improve Suboptimal Prescribing in Nursing Homes: A Narrative Review

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Abstract

Background—Appropriate medication prescribing for nursing home residents remains a challenge.

Objective—The purpose of this study was to conduct a narrative review of the published literature describing randomized controlled trials that used interventions to improve suboptimal prescribing in nursing homes.

Methods—The PubMed, International Pharmaceutical Abstracts, and EMBASE databases were searched for articles published in the English language between January 1975 and December 2009, using the terms *drug utilization*, *pharmaceutical services*, *aged*, *long-term care*, *nursing homes*, *prescribing*, *geriatrics*, and *randomized controlled trial*. A manual search of the reference lists of identified articles and the authors' files, book chapters, and recent review articles was also conducted. Abstracts and posters from meetings were not included in the search. Studies were included if they: (1) had a randomized controlled design; (2) had a process measure outcome for quality of prescribing or a distal outcome measure for medication-related adverse patient events; and (3) involved nursing home residents.

Results—Eighteen studies met the inclusion criteria for this review. Seven of those studies described educational approaches using various interventions (eg, outreach visits) and measured suboptimal prescribing in different manners (eg, adherence to guidelines). Two studies described computerized decision-support systems to measure the intervention's impact on adverse drug events (ADEs) and appropriate drug orders. Five studies described clinical pharmacist activities, most commonly involving a medication review, and used various measures of suboptimal prescribing, including a measure of medication appropriateness and the total number of medications prescribed. Two studies each described multidisciplinary and multifaceted approaches that included heterogeneous interventions and measures of prescribing. Most (15/18; 83.3%) of

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these studies reported statistically significant improvements in ≥1 aspect of suboptimal prescribing. Only 3 of the studies reported significant improvements in distal health outcomes, and only 3 measured ADEs or adverse drug reactions.

Conclusions—Mixed results were reported for a variety of approaches used to improve suboptimal prescribing. However, the heterogeneity of the study interventions and the various measures of suboptimal prescribing used in these studies does not allow for an authoritative conclusion based on the currently available literature.

Keywords

drug utilization; prescribing; nursing home; long-term care; geriatrics

INTRODUCTION

Medication prescribing for nursing home residents ≥65 years of age is a complex process that can potentially improve quality of life, prolong life expectancy, and/or cure disease. However, sufficient data have been published over the past 3 decades suggesting that prescribing can be suboptimal (ie, overuse, underuse, or misuse).[1] Of concern is that these different types of suboptimal prescribing can lead to adverse health outcomes, especially medication-related adverse patient events (ie, adverse drug events [ADEs], adverse drug withdrawal events, and therapeutic failures).[1–4]

Various research approaches have been used in attempts to improve prescribing practices among physicians in multiple clinical care settings.[1,5–11] These include interventions to improve education of the health care staff providing patient care, to utilize computerized decision-support systems, to use clinical pharmacy interventions, to use a multidisciplinary approach, and to use a multifaceted approach. The conclusions of these various interventions have produced mixed results, leading to further confusion on effective interventions to improve prescribing. Unfortunately, previous reviews either are outdated or focus on a single drug class (eg, psychotropic drugs) or intervention (eg, pharmacists).[1,8,11] Because a review of interventions to improve prescribing in nursing homes has not been conducted in almost 2 decades,[1] this updated review is both timely and relevant. The objective of this study was to conduct a narrative review of the published literature, describing the current state of the art of medication prescribing in nursing homes and interventions for improvement.

METHODS

With the aid of a trained medical librarian, articles that assessed improving suboptimal prescribing among elderly nursing home residents (≥65 years of age) were identified through searches of the PubMed, International Pharmaceutical Abstracts (IPA), and EMBASE databases for articles published in English between January 1975 and December 2009. The search combined the terms *drug utilization*, *pharmaceutical services*, *aged*, *long-term care*, *nursing homes*, *prescribing*, *geriatrics*, and *randomized controlled trial* (RCT). Additional articles were identified by a manual search of the reference lists of identified articles and the authors' files, book chapters, and recent review articles. Abstracts and posters from meetings were not included in the literature search. The authors then reviewed the identified studies and included those that: (1) had a randomized controlled design; (2) had a process measure outcome for quality of prescribing or a distal outcome measure for medication-related adverse patient events; and (3) involved nursing home residents. Identified articles were grouped according to type of intervention using a previously published approach.[7]

RESULTS

Twenty-three publications were identified from the literature search, 5 of which were excluded. Three of the excluded trials were not randomized,[12–14] one of the trials did not focus on improving prescribing as a main outcome,[15] and one was a placebo-controlled withdrawal trial that assessed stopping long-term anti-psychotic treatment as the primary outcome.[16] The 18 studies that met the inclusion criteria are summarized in the table.[17–34] Seven of those studies described educational approaches using various interventions (eg, outreach visits) and measured suboptimal prescribing in different manners (eg, adherence to guidelines). Two studies described computerized decision-support systems to measure the intervention's impact on ADEs and appropriate drug orders. Five studies described clinical pharmacist activities, most commonly involving a medication review, and used various measures of suboptimal prescribing, including a measure of medication appropriateness and the total number of medications prescribed. Two studies each described multidisciplinary and multifaceted approaches that included heterogeneous interventions and measures of prescribing.

The following descriptions provide further information about these individual trials, categorized by type of intervention. Of note, the trials were categorized by the type of intervention rather than the object of the intervention. For example, an educational intervention directed at a multidisciplinary target audience would be classified under the *educational approaches* section.

Educational Approaches

A study by Avorn et al[17] examined the impact of an academic detailing intervention on the use of psychotropic medications in nursing home residents. The study included 823 elderly residents from 6 randomized matched pairs of nursing homes and lasted 5 months. The intervention consisted of a clinical pharmacist educating physicians, nurses, and nurses' aides in the principles of geriatric psychopharmacology. The intervention was associated with a significant decrease in the use of antipsychotic drugs (32% in experimental group vs 14% in control group; mean difference, −18%; 95% CI, −3% to −33%; $P < 0.05$). However, the intervention did not have a significant impact on the use of hypnotics (45% vs 21%, respectively; mean difference, −24%; 95% CI, −54% to 5%) or long half-life benzodiazepines (BZDs) (20% vs 9%; mean difference, −11%; 95% CI, −38% to 15%). Overall, inappropriateness scores for use of psychoactive drugs declined significantly in the intervention nursing homes compared with those from the control nursing homes (27% vs 8%, respectively; $P = 0.02$). Most (4/6) measures of clinical status (mental status, anxiety, behavior, and sleep) remained unchanged in both groups. Residents of the control homes were less likely than residents of intervention homes to maintain or improve their performance on memory testing (46% vs 69%; rate ratio = 0.6; 95% CI, 0.3 to 1.0); they also were less likely to maintain or improve scores on mental status testing (44% vs 62%; rate ratio = 0.7; 95% CI, 0.4 to 1.1) on 2 measures of cognitive function (delayed-recognition-span test for memory and the Mini-Mental State Examination [MMSE]), although the differences were not statistically significant. In other words, residents of intervention homes experienced less deterioration on these measures of cognitive function. However, residents of intervention homes were more likely to report depression (56% vs 27%; rate ratio = 2.0; 95% CI, 1.1 to 3.9; $P < 0.05$). This study was limited by its use of an un-validated measure of psychotropic prescribing quality and its low power to detect differences in health outcomes given the short follow-up period (30 days). Nonetheless, the intervention had some beneficial effects on improving suboptimal psychotropic prescribing for elderly nursing home residents.

A 3-month study by Stein et al[18] examined the impact of an academic detailing intervention on the use of NSAIDs in 147 older residents (≥65 years of age) in 10 matched pairs of nursing homes. A 30-minute education training session was held in intervention homes for nurses and nurse's aides on alternatives to NSAIDs for managing musculoskeletal pain. A study investigator also met with directors of nursing and administrators in the intervention homes. A study physician visited or talked by telephone with prescribing physicians in intervention homes to review the risks and benefits of NSAIDs, an algorithm for stopping use of these agents, and the available alternatives to NSAIDs. The intervention group had significant reductions in the mean days per week that NSAIDs were used (−5.1 days vs −0.8 day for the control group; $P < 0.001$) and significant increases in the use of acetaminophen (APAP) (3.1 days vs 0.31 day for controls; $P < 0.001$). No statistically significant differences in any of the 7 health outcome measures were found between the 2 groups. It is likely that the study had limited power to detect differences in distal health outcomes given the small sample size.

Monette et al[19] conducted a 4-month clustered trial in 8 public Canadian long-term care facilities involving 36 prescribing physicians. The intervention included written materials about appropriate management of common infections, which were mailed to physicians along with specific information about their prescribing patterns for anti-infectives. Nonadherent, or suboptimal, prescribing was defined as any anti-infective prescription that differed from the mailed guidelines in ≥1 of the following areas: the choice of the anti-infective according to the diagnosis; dosage; frequency; duration; or adjustment for creatinine clearance, when indicated. The physicians in the intervention group were 64% less likely to prescribe nonadherent antibiotics than were physicians in the control group (odds ratio [OR] = 0.36; 95% CI, 0.18–0.73; $P < 0.05$). No information was collected on any additional health outcomes. The study was limited by the use of unvalidated explicit criteria to measure suboptimal prescribing and the use of non-blinded evaluators of the outcome measures. In addition, the generalizability of the results to the United States or other countries is unknown.

Fossey et al[20] tested the effectiveness of training staff from 6 paired nursing homes in the United Kingdom on antipsychotic use in 349 residents (median age, 82 years) with dementia. The in-facility training was done by a psychologist, a nurse, and occupational therapists over 10 months. In addition, 3 geriatric psychiatrists reviewed residents' medical records and wrote specific recommendations to prescribing physicians to discontinue antipsychotics that had been given for >3 months, especially if behavioral problems had subsided. Study team members made initial and 12-month follow-up assessments of any use of antipsychotics, the dosages used, and behavioral complications (based on the Cohen-Mansfield Agitation Inventory[35]). The proportion of residents taking neuroleptics was significantly lower in the intervention homes than in the control homes at 12 months (23.0% vs 42.1%, respectively; mean reduction in neuroleptic use, 19.1%; 95% CI, 0.5%–37.7%; $P = 0.045$). This improvement did not result in changes in the use of other psychotropics or behavioral complications. It is important to note that antipsychotic use at baseline (50% in control homes, 47% in intervention homes) was nearly twice as high as current levels in US nursing homes; the cost-effectiveness of such a labor-intensive, hands-on intervention was not provided.

A study by Crotty et al[21] assessed the impact of an outreach visit intervention delivered by a pharmacist on fall reduction and stroke prevention in a residential care setting over 7 months. The study included 897 participants at baseline and 902 participants at the 7-month follow-up from 20 residential care facilities, 715 of whom (mean age, 83.4 years in control homes, 84.7 years in intervention homes) had data at both time points; 452 residential care staff were surveyed, and 121 physicians were invited to participate, 61 of whom attended

outreach visits. The intervention consisted of two 30-minute outreach visits by a pharmacist. The first visit focused on relevant evidence related to fall reduction and stroke prevention using guidelines for community-based patients. The second visit included detailed audit information about fall rates, risk of psychotropic drug use, and stroke risk-reduction practices (eg, blood pressure monitoring, use of aspirin and warfarin) using facility-specific information. Case notes were audited by nurses blinded to allocation for demographic information, diagnoses, and stroke risk factors. The only significant result of this study was the greater use of "as required" antipsychotics in the intervention group than in the control group (relative risk [RR] = 4.95; 95% CI, 1.69–14.50; $P < 0.05$). No significant difference was found between the 2 groups in the numbers of residents "at risk of stroke" on aspirin at follow-up (RR = 0.54; 95% CI, 0.29–1.00) or the 3-month fall rate (RR = 1.17; 95% CI, 0.86–1.58). This study was limited by the short time frame of the trial (7 months), which may not have allowed detection of changes in prescribing patterns. In addition, because of the short time frame, the total number of outreach visits (61) may not have been large enough to have a sustainable effect on suboptimal prescribing.

A study by Schmidt et al[22] assessed the impact of a pharmacist outreach program on psychotropic drug use that targeted a multidisciplinary team consisting of physicians, pharmacists, nurses, and nurses' aides. The 12-month study included 1854 residents of 33 long-term care facilities. The investigators placed drugs into 1 of 3 categories: (1) nonrecommended (eg, tricyclic antidepressants), (2) acceptable (eg, selective serotonin reuptake inhibitors [SSRIs]), and (3) other drugs not categorized by the Swedish Medical Products Agency. The intervention led to significant decreases in the prescribing of antipsychotics (19%; $P = 0.007$), nonrecommended BZDs (37%; $P < 0.001$), and nonrecommended tricyclic antidepressants (59%; $P < 0.001$) in the intervention group. Orders for acceptable antidepressants increased in the intervention group (584% increase in SSRI use; $P < 0.001$) as well as in the control group (315% increase in SSRI use; $P < 0.001$); however, no significant reductions in other drug classes were reported in the control group. This study was limited in that it did not assess any clinical outcomes associated with improving psychotropic prescribing.

Naughton et al[23] compared a continuing-education strategy for the treatment of nursing home–acquired pneumonia (NHAP) targeting individual physicians from skilled nursing facilities (SNFs) and an educational strategy on NHAP targeting both SNF nurses and physicians. The continuing-education tool involved promotion of a set of guidelines developed by the investigators to improve antibiotic prescribing for NHAP. Ten SNFs were randomly assigned to either the physician-only control group or to the multidisciplinary intervention group (ie, nurses and physicians); the study lasted 6 months. All residents with NHAP in the participating facilities (total, 2375 beds) were included in the study. There were 350 episodes of NHAP, which were the basis of analysis for this study. The investigators found that the intervention did not significantly improve the rate of treatment among the preintervention and postintervention groups according to the guidelines. The use of parenteral antibiotics in accordance with guidelines increased from a preintervention level of 50% to a postintervention level of 81.8% in the SNFs randomized to the multidisciplinary intervention and from 64.5% to 69.0% in the physician-only group (both, P = NS). Interestingly, a statistically significant increase in prescribing of parenteral antibiotics according to the guidelines was detected only after both groups of SNFs were combined in the analysis (data not reported; $P < 0.02$). The intervention also did not yield a significant difference in the other primary outcomes measured. Thus, in this study, neither strategy had a significant effect on antibiotic prescribing in the SNFs studied.

Computerized Decision-Support Systems

A study by Gurwitz et al[24] evaluated the efficacy of a computerized provider order-entry system with clinical decision support for preventing ADEs in the long-term care setting. The study design was a clustered RCT conducted in 2 large long-term care facilities and involved 1118 residents in 29 resident care units. The trial lasted 12 months at one site and 6 months at the other. Before study initiation, the investigators developed 39 clinical decision-support rules and 41 corresponding alerts based on the following principles: that messages are evidence-based; practitioners should perceive the message as useful and informative; and the system should have only a modest effect on the time required for the practitioner to complete an order.[36] The resident care units, each equipped with computerized provider order-entry systems, were randomized to having a clinical decision-support system (intervention) or not (control units). Physician pairs then independently classified incidents according to the following criteria: whether an ADE was present, the severity of the event, and whether the event was preventable. Within intervention units, 411 ADEs occurred over 3803 resident-months of observation; 152 (37.0%) were deemed preventable. Within control units, 340 events occurred over 3257 resident-months of observation; 126 (37.1%) were deemed preventable. Comparing inter- vention and control units, the adjusted rate ratios were 1.06 (95% CI, 0.92–1.23) for all ADEs and 1.02 (95% CI, 0.81–1.30) for preventable events (both, P = NS). In this study, computerized provider order entry with clinical decision support did not reduce the rate of ADEs or preventable ADEs in the long-term care setting. Possible reasons for the negative findings include alert burden (ie, >50% of the alerts were determined to be unnecessary),[37] limited scope of the alerts (ie, the alerts incorporated into this system addressed only a minority of ADEs identified in this study), and clinical and laboratory information not being integrated.

A study by Field et al[25] determined whether a computerized provider order-entry system with clinical decision support improves the quality of prescribing for long-term care residents with renal insufficiency. The study design was a clustered RCT, was conducted in a single long-term care facility, and involved 833 residents (mean age, 86.3 years in intervention units, 86.2 years in control units) in 22 units over 12 months. Before study initiation, the research team developed a list of 62 drugs selected from hospital-based, dosing-alert systems that either required dose or frequency adjustments or should be avoided altogether in residents with renal insufficiency. The rates of alerts were nearly equal in the intervention and control units: 2.5 per 1000 resident-days in the intervention units and 2.4 in the control units. The proportions of dose alerts for which the final drug orders were appropriate were similar between the intervention and control units (RR = 0.95; 95% CI, 0.83–1.1; P = NS); conversely, the remaining alert categories had significantly higher proportions of final drug orders that were appropriate in the intervention units: RR = 2.4 for maximum frequency (95% CI, 1.4–4.4; $P < 0.05$), 2.6 for drugs that should be avoided (95% CI, 1.4–5.0; $P < 0.05$), and 1.8 for alerts to acquire missing information (95% CI, 1.1–3.4; $P < 0.05$). A computerized decision-support system for prescribing medications among long-term care residents with renal insufficiency can improve certain aspects of prescribing, including the maximum administration frequency, which medications should be avoided, and when missing information prevents the calculation of creatinine clearance. One of the limitations of this study was the possibility of cross-contamination of the effect of the intervention on prescribing. The physicians caring for residents provided care in both intervention and control units; thus, their prescribing patterns in the intervention units may have influenced their prescribing in the control units.

Clinical Pharmacy

A study by Crotty et al[26] assessed the impact of adding a pharmacist transition coordinator on evidence-based medication management and health outcomes in patients moving from

the hospital to a long-term care facility for the first time. The study included 110 older adults (mean age, 82.7 years) assigned to 85 long-term care facilities. Patients were randomly allocated either to receive the services of the pharmacist transition coordinator or to undergo the usual hospital discharge process over 8 weeks. The intervention was not associated with a significant change in the Medication Appropriateness Index (MAI) score (range, 0–18 per drug; higher scores = more inappropriate) from baseline in the intervention group (mean score, 3.2; 95% CI, 1.8–4.6 at baseline vs 2.5; 95% CI, 1.4–3.7 at 8 weeks); however, the MAI score worsened in the control group (mean score, 3.7; 95% CI, 2.2–5.2 for intervention group vs 6.5; 95% CI, 3.9–9.1 for control group at 8 weeks; $P = 0.007$). In addition, the intervention group showed a significant protective effect of the intervention against worsening pain (RR = 0.55; 95% CI, 0.32–0.94; $P = 0.023$) and hospital usage (RR = 0.38; 95% CI, 0.15–0.99; $P = 0.035$), but did not differ significantly from control patients in terms of ADEs (RR = 1.05; 95% CI, 0.66–1.68), falls (RR = 1.19; 95% CI, 0.71–1.99), worsening mobility (RR = 0.39; 95% CI, 0.13–1.15), worsening behaviors (RR = 0.52; 95% CI, 0.25–1.10), or increased confusion (RR = 0.59; 95% CI, 0.28–1.22). This study was limited by the small sample size, which may have limited the power of the study and the ability to detect significant differences in secondary outcomes.

A study by Zermansky et al[27] assessed the impact of a pharmacist-conducted clinical medication review among residents of 65 nursing, residential, and mixed-care homes. The study included 661 residents ≥65 years of age and lasted 6 months. The intervention was a clinical medication review by a pharmacist, who then made recommendations to the general practitioner (GP) for approval and implementation. Control residents received usual GP care. The intervention led to a significant difference in the mean number of drug changes per resident: 3.1 for the intervention group versus 2.4 for the control group ($P < 0.001$). The GP accepted 75.6% (565/747) of the pharmacist's recommendations, and 76.6% (433/565) of the accepted recommendations were implemented. The mean number of falls per resident was 0.8 for the intervention group versus 1.3 for the control group ($P < 0.001$). However, no significant differences were found between the intervention and control groups for the following secondary outcomes: GP consultations per resident (mean, 2.9 and 2.8, respectively), hospitalizations (mean, 0.2 and 0.3), deaths (51/331 [15.4%] and 48/330 [14.5%]), Barthel score (mean, 9.8 and 9.3), Standardized MMSE score (mean, 13.9 and 13.8), number of drugs per resident (mean, 6.7 and 6.9), or cost of drugs per resident (mean, £42.24 and £42.94 [~$62.79 and $63.83 in US$, respectively][38] per 28 days). This study was limited by the underachievement of the targeted sample size and the short duration of the trial. Moreover, no validated explicit or implicit measures of suboptimal prescribing were used.

A study by Furniss et al[28] assessed the impact of active medication review by a pharmacist. This 8-month study included 330 nursing home residents from 14 homes. The intervention involved a medication review by a pharmacist followed up 3 weeks later to see whether the suggested changes had been implemented and to assess whether any immediate problems had occurred after making the changes in medication. At the end of the intervention, the mean number of drugs that were prescribed had decreased in both the intervention group (5.1 at baseline vs 4.2 at 8 months) and the control group (4.9 at baseline vs 4.4 at 8 months); however, the difference between the 2 groups was not statistically significant. Interestingly, the intervention group experienced a greater deterioration in cognitive function (mean MMSE score, 12.5 vs 17.1 in the control group; P = NS). The intervention group experienced significantly greater behavioral disturbance (mean Crichton-Royal Behaviour Rating Scale score, 19.4 vs 14.5 in the control group; $P = 0.02$). However, changes in depression (mean Geriatric Depression Scale score, 3.86 in the intervention group vs 4.41 in the control group) and quality of life (mean Brief Assessment Schedule Depression Cards score, 3.77 in the intervention group vs 3.26 in the control group) were not significantly

different statistically. The number of deaths was significantly lower in the intervention group than in the control group during the intervention period (4 vs 14; $P = 0.028$) but not during the study period as a whole (26 vs 28). As in the previously described studies,[17,19,27] this study was limited by the lack of a validated measure of suboptimal prescribing. The clinical impact of the lower number of prescribed drugs in the intervention group is uncertain. Furthermore, cognitive, depressive, and quality-of-life outcomes are multifactorial; thus, an intervention focused on medications may be less likely to have an important impact on such outcomes.

A study by Roberts et al[29] assessed the impact of a clinical pharmacy program involving development of professional relationships, nurse education on medication issues, and individualized medication reviews. This 12-month study included 905 residents in 13 intervention homes and 2325 residents in 39 control homes and was a clustered RCT in which an intervention home was matched to 3 control homes. The intervention significantly reduced the use of BZDs, NSAIDs, laxatives, and histamine H_2-receptor antagonists/antacids compared with the control groups (change in number of prescription items/year/1000 residents [trial period minus baseline period], intervention minus control: −875, −239, −451, −285, and −82, respectively; all, $P < 0.05$). No significant difference was found in the use of digoxin or diuretics (change in number of prescription items/year/1000 residents [trial period minus baseline period], intervention minus control: −12 and −355, respectively). Overall drug use in the intervention group was reduced by 14.8% relative to the control group (P = NS). Finally, no significant changes in morbidity indices (eg, hospitalization, ADEs, changes in disability index) or survival rates (hazard ratio = 0.85; 95% CI, 0.68–1.06) were found between the intervention and control groups. This study was limited by the lack of a validated measure of suboptimal prescribing and its short duration.

A study by Thompson et al[30] assessed the impact of clinical pharmacist prescribing and monitoring under the supervision of a family practitioner compared with a traditional-care control group. The study initially included 152 residents from a single SNF and lasted 12 months; 139 residents (mean age, 85.1 years in the intervention group and 86.3 years in the control group) were assessed during the study year. The intervention led to a significantly lower mean number of drugs per resident in the intervention group than in the control group (5.7 vs 7.1, respectively; $P = 0.04$). In addition, the investigators reported that the intervention group had a numerically lower number of deaths (3/67 [4.48%] vs 10/72 [13.89%]; $P = 0.05$); however, this was not a statistically significant finding and should be interpreted with caution. Furthermore, significantly more residents were discharged to lower levels of care in the intervention group than in the control group (8/67 [11.94%] vs 2/72 [2.78%]; $P = 0.03$). This study reported that clinical pharmacists working collaboratively with family practice physicians can have a positive impact on the number of drugs prescribed and the discharge rate. Use of a single-center study with only 2 pharmacists limited the generalizability of the study results.

Multidisciplinary Approaches

Another study by Crotty et al[31] assessed the impact of 2 multidisciplinary case conferences involving the resident's GP, a geriatrician, a pharmacist, and residential care staff. This study lasted 3 months and included 154 residents (mean age, 85.3 years in the intervention group and 83.6 years in the control group) with medication problems and/or challenging behaviors from 10 high-level aged-care facilities. The mean change in MAI score was greater in the intervention group (4.1; 95% CI, 2.1 to 6.1) than in the control group (0.4; 95% CI, −0.4 to 1.2; $P < 0.001$). The intervention group also had a significantly greater reduction in mean MAI score for BZDs (0.73; 95% CI, 0.16 to 1.30) than did the control group (−0.38; 95% CI, −1.02 to 0.27; $P = 0.017$). Overall, no significant changes in resident behaviors were found after the intervention. Furthermore, the nonstudy residents in the

facility were not affected by the case-conferencing approach, ruling out the possibility that this approach would carry over within the facility.

A study by Ulfvarson et al[32] assessed the impact of medication reviews conducted by a specialist in clinical pharmacology and a specialist in cardiology among 80 nursing home residents (mean age, 87 years) in 9 nursing homes over a 3-month period. Symptoms related to heart failure or adverse reactions to cardiovascular drugs were recorded using a questionnaire. The intervention led to changed drug therapy that was suggested for 40 residents, and the advice was followed by the responsible physician for 19 residents. However, no significant changes from baseline to follow-up (2 weeks and 3 months after intervention) were found in the mean total scores of any of the study questionnaires (ie, symptoms related to heart failure, adverse reactions to cardiovascular drugs, quality of life, or activities of daily living). This study was limited by the small sample size, resident self-reporting of activities of daily living, and assessment of only cardiovascular drugs.

Multifaceted Approaches

Colón-Emeric et al[33] conducted a single-blinded, 6-month RCT in 67 nursing facilities in 2 states (606 residents; mean age, 83.0 years in the intervention group and 85.6 years in the control group). The investigators used a 6-pronged intervention that included the following behavior change strategies: continuing-education modules on osteoporosis evaluation and treatment; reminders; audit and feedback; academic detailing from osteoporosis opinion leaders; case-based teleconference on osteoporosis quality improvement; and an osteoporosis toolkit. Interestingly, the investigators targeted nursing and medical staff as well as the nursing home administrators. The nursing and medical staff members were asked to complete the continuing-education modules for credit. The director of nursing and the physicians then received ≥3 reminders via telephone, e-mail, and/or fax to complete the modules. The administrators of the intervention nursing homes received audit and feedback reports comparing their facility's compliance with that of other nursing homes in their state, and they were asked to pass these reports along to the medical providers with privileges in their facilities. Furthermore, academic detailing occurred via telephone calls that were placed to providers by osteoporosis opinion leaders. Nursing and medical providers were also invited to attend 1 of 4 scheduled teleconferences, and the participants received an osteoporosis tool-kit that included posters, brochures, and links to Web sites providing information about falls and osteoporosis prevention (ie, osteoporosis medication and hip protectors). The use of osteoporosis prevention increased from 32.6% to 40.6% (8.0% difference) in the intervention homes and from 38.6% to 39.2% (0.6% difference) in the control homes; however, neither change was statistically significant. Completion of the educational module (OR = 4.8; 95% CI, 1.9–12.0; $P = 0.001$) and direct physician contact by an academic detailer (OR = 4.5; 95% CI, 1.1–18.2; $P = 0.03$) were significantly associated with prescribing osteoporosis pharmacotherapy. This study was limited by low participation rates in the educational components of the intervention and high baseline treatment rates (~70%) before the intervention, which threatened a ceiling effect.

A study by Loeb et al[34] assessed the impact of the development of a diagnostic and treatment algorithm for urinary tract infections (UTIs) implemented at the nursing home level using small group interaction sessions for nurses, videotapes, written material, outreach visits, and one-on-one interviews with physicians. This 12-month study included 24 nursing homes (12 receiving the multifaceted intervention and 12 receiving usual care); outcomes were measured in 4217 residents. The intervention led to fewer courses of antimicrobials for suspected UTIs per 1000 resident-days (1.17 courses in the intervention group vs 1.59 courses in the usual-care group; weighted mean difference, −0.49; 95% CI, −0.93 to −0.06; $P < 0.05$). Overall, no significant differences in hospital admissions or mortality rates were found between the study arms. The proportion of total antimicrobials

prescribed for suspected UTIs in the intervention homes was significantly lower than in the usual-care homes (28% vs 39% of antimicrobial courses; weighted mean difference, −9.6%; 95% CI, −16.9% to −2.4%; $P < 0.05$). This study was limited in that it was underpowered to detect significant differences in hospital admissions and mortality rates between the 2 study groups. Furthermore, it was not possible to determine which part of the multifaceted approach was most successful.

DISCUSSION

No current or updated narrative review of RCTs evaluating interventions to improve prescribing in nursing homes was found in the literature search. In a review that was published in 1990,[1] only one RCT had been published on this topic at the time. Only 18 trials met the inclusion criteria for the present review. These 18 trials used a variety of interventional approaches. Previous research assessing the process of prescribing has been conducted in a variety of settings.[1,5–11] The present review found that 15 (83.3%) of the 18 studies, regardless of the interventional approach taken, reported a significant improvement in ≥1 prescribing-related process outcome. Unfortunately, clinical outcomes were much less likely to be improved significantly, probably because the studies were underpowered to detect such differences in multifactorial outcomes. One positive finding is that 3 recent studies[24,26,32] did examine medication-related adverse patient events.

It is interesting to note that 3 major medication classes for unique conditions were targeted by the studies included in this review: (1) central nervous system (CNS) medications, (2) anti-infectives, and (3) musculoskeletal system medications. The first class, CNS medications, was studied in 4 of the trials.[17,20–22] Educational approaches were used in all of these studies, and the targeted medications included neuroleptics, anti- psychotics, and antidepressants. This is an important target because ~50% of nursing home residents are cognitively impaired.[39] Thus, CNS medications should be used cautiously and with diligent monitoring because of the potential to both worsen cognitive impairment and lead to falls. Prescribing-related process outcomes were found to be improved in almost all of the studies; specifically, a significant decrease (19%–59%; all, $P < 0.05$) in the proportion of residents taking CNS medications was reported in 3 of the 4 studies.[17,20,22] Regarding clinical outcomes, falls were measured in only one of the studies,[21] with no significant difference found between the intervention and control groups. It is important to note that simply decreasing the number of CNS medications is not as clinically important as the potential benefits of reducing falls and improving cognitive function without worsening of the underlying disease process. Therefore, future studies should focus on measuring the clinical outcomes associated with interventions targeted at these medication classes.

Anti-infectives, the second class examined, were assessed in 3 of the studies.[19,23,34] Two studies[19,23] used an educational approach to improve prescribing by reeducating the prescribers on appropriate antibiotics and duration of therapy for infections commonly found in nursing homes (eg, UTIs, NHAP, skin and soft-tissue infections). One study[34] used a multifaceted approach. Two of the 3 studies[23,34] measured clinical outcomes, but neither study reported statistically significant results. One study[34] measured hospital admissions and mortality rates, whereas the other study[23] measured the 30-day postintervention mortality rate. It is promising that all of the studies found significant improvements in the appropriateness of antibiotic prescribing after intervention based on the guidelines or recommendations implemented in the trials.

As with any educational intervention, the possibility exists for the intervention's effect to decrease over time. Future studies should build on this research by identifying appropriate clinical outcomes to measure as primary outcomes in the nursing home setting and by

conducting follow-up studies to assess retention of the knowledge gained from the educational intervention.

The final medication class, musculoskeletal system medications, was examined in 2 studies.[18,33] One study[18] addressed musculoskeletal pain using an educational intervention, and the other study[33] focused on osteoporosis management using a multifaceted approach. The trial using an educational approach reported a significant decrease in the mean number of days of NSAID use per week in the intervention group (decrease of 7.0 to 1.9 days; $P < 0.001$) and a significant increase in the mean number of days of APAP use in the intervention group (increase of 3.1 days; $P < 0.001$) compared with the control group.[18] The multifaceted-approach trial reported that completion of an educational module ($P = 0.001$) and direct physician contact by an academic detailer ($P = 0.03$) were significantly associated with prescribing osteoporosis pharmacotherapy.[33] Unfortunately, neither trial found a significant improvement in a clinical outcome. Because osteoarthritis and osteoporosis are common causes of disability and decreased quality of life among older adults,[40,41] more attempts should be made to improve prescribing for patients with these diseases. These 2 trials[18,33] were only 3 to 6 months in length; longer studies might be needed to detect a difference in musculoskeletal pain and/or falls.

This review has several potential limitations worth mentioning. Publication bias may exist because negative studies are less likely to have been published. In addition, although the PubMed, IPA, and EMBASE databases were searched for relevant articles, it is possible that some studies may have been missed if they were indexed in other databases. To minimize the chance of missing such studies, the authors manually searched the reference lists of the identified articles, recent review articles, as well as their personal files to identify potential studies for inclusion. The search strategy was also limited to the English language, to older adults (=65 years of age), to nursing home residents, and to RCTs, because the intent of this study was to evaluate the impact of interventions on older adults in the nursing home setting. Using such strict inclusion criteria may limit the generalizability of this review.

CONCLUSIONS

Studies using various types of interventions have reported mixed findings with regard to improving prescribing practices for older adults in nursing homes. Because of the heterogeneous interventions that were used and the outcomes that were measured, it is difficult to make a generalized conclusion. However, it is imperative to focus future research on improving prescribing in nursing homes as the aging population continues to grow and more medications reach the market. Furthermore, it is critical for future research to study clinical outcomes and not just report process measures such as prescribing and monitoring.

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Table

Summary of randomized controlled trials designed to improve medication prescribing in nursing homes.[17–34]

Trial	Randomization	Intervention	Duration of Intervention	Results*
Educational approaches				
Avorn et al (1992)[17]	6 Matched pairs of nursing homes; 823 residents	Educational program, by clinical pharmacist in geriatric psychopharmacology, provided to physicians, nurses, and nurse's aides	5 Months	*Process*: Use of antipsychotic drugs was discontinued in more residents in intervention nursing homes than in control homes (32% vs 14%; mean difference, −18%; 95% CI, −3% to −33%; $P < 0.05$); other drugs were discontinued in more intervention homes than in control homes: hypnotics (45% vs 21%; mean difference, −24%; 95% CI, −54% to 5%; P = NS) and long half-life BZDs (20% vs 9%; mean difference, −11%; 95% CI, −38% to 15%; P = NS); index scores of psychoactive drug use (magnitude and appropriateness) decreased significantly more in intervention homes than in control homes (27% vs 8%; $P = 0.02$) *Outcomes*: Residents of intervention nursing homes who were initially taking antipsychotic drugs showed less deterioration on several measures of cognitive function than did residents of control homes, but were more likely to report depression (56% vs 27%; rate ratio = 2.0; 95% CI, 1.1 to 3.9; $P < 0.05$)
Stein et al (2001)[18]	10 Matched pairs of nursing homes; 147 residents	Educational program for physicians and nursing home staff, including risks/benefits of NSAIDs in elderly and algorithm that substituted APAP, topical agents, and nonpharmacologic measures for treatment of noninflammatory musculoskeletal pain	3 Months	*Process*: Mean number of days of NSAID use in the 7-day periods before the baseline and 3-month assessments decreased from 7.0 to 1.9 days in intervention subjects and from 7.0 to 6.2 days in control subjects ($P < 0.001$); APAP use in the 7 days before the 3-month assessment increased by 3.1 days in residents of intervention homes compared with 0.31 day in residents of control homes ($P < 0.001$) *Outcomes*: Similar proportion of subjects in control (32.5%) and intervention (35.4%) groups had worsening of their arthritis pain score (P = NS)
Monette et al (2007)[19]	36 Physicians from 8 long-term care facilities	Mailing antibiotic guidelines to physicians along with their antibiotic prescribing profile covering the previous 3 months (targeted infections were UTIs, lower respiratory tract infections, skin and soft-tissue infections, and septicemia); each antibiotic was classified as adherent or nonadherent to the guidelines	4 Months	*Process*: Physicians in the experimental group were 64% less likely to prescribe nonadherent antibiotics than were those in the control group at the end of the intervention period (OR = 0.36; 95% CI, 0.18–0.73; $P < 0.05$)
Fossey et al (2006)[20]	6 Paired nursing homes (12 specialist nursing homes); 349 residents	Training and support intervention delivered to nursing home staff focusing on alternatives to drugs for management of agitated behavior in dementia	10 Months	*Process*: At 12 months, the proportion of residents taking neuroleptics in the intervention homes (23.0%) was significantly lower than that in the control homes (42.1%) (mean reduction in neuroleptic use, 19.1%; 95% CI, 0.5%–37.7%; $P = 0.045$) *Outcomes*: No significant differences were found in the levels of agitated or disruptive behavior between residents of intervention and control homes

Trial	Randomization	Intervention	Duration of Intervention	Results*
Crotty et al (2004)[21]	20 Residential care facilities; 897 residents at baseline and 902 residents at follow-up (715 residents with data at both time points)	Two outreach visits, delivered by a pharmacist, providing relevant evidence and detailed audit information about fall rates, psychotropic drug prescribing, and stroke risk-reduction practices	7 Months	*Process*: No significant differences between groups for psychotropic drug use before or after the intervention, except for significantly greater use of "as required" antipsychotics in the intervention group than in the control group (RR = 4.95; 95% CI, 1.69–14.50; $P < 0.05$); no significant difference between groups in the number of residents "at risk of stroke" on aspirin at follow-up (RR = 0.54; 95% CI, 0.29–1.00) *Outcomes*: No significant differences between the intervention and control groups for the 3-month fall rate (RR = 1.17; 95% CI, 0.86–1.58)
Schmidt et al (1998)[22]	33 Long-term care facilities; 1854 residents	Pharmacist outreach program designed to influence drug use through improved teamwork among physicians, pharmacists, nurses, and nurse's aides	12 Months	*Process*: Significant decrease in the prescribing of antipsychotics (19%; $P = 0.007$), BZDs (37%; $P < 0.001$), and tricyclic antidepressants (59%; $P < 0.001$) in the intervention group compared with the control group; orders for more acceptable antidepressants increased in the intervention group (584% increase in SSRI use; $P < 0.001$) and in the control group (315% increase in SSRI use; $P < 0.001$); no significant reductions were found in other drug classes
Naughton et al (2001)[23]	10 SNFs; 2375 residents	Continuing-education intervention for treatment of NHAP, including small group consensus process limited to physicians and a similar intervention that included physicians and nurses within randomly selected SNFs	6 Months	*Process*: Nonsignificant improvement in prescribing of parenteral antibiotics in accordance with the guidelines in the intervention group (physician plus nurses), from 50% before intervention to 81.8% after intervention; physician-only group improved from 64.5% to 69.0%; after secondary multivariate analysis, significantly more of the postintervention episodes of NHAP were treated with parenteral antibiotics in accordance with the guidelines ($P < 0.02$) *Outcomes*: No significant difference in 30-day postintervention mortality rate for episodes with guideline indications for oral antibiotics or for parenteral antibiotics
Computerized decision-support systems				
Gurwitz et al (2008)[24]	2 Long-term care facilities; 1118 residents of 29 units	Clinical decision-support system designed for preventing ADEs	12 Months at one study site and 6 months at the other	*Process*: 411 ADEs (152 [37.0%] deemed preventable) occurred over 3803 resident-months of observation in the intervention units vs 340 ADEs (126 [37.1%] deemed preventable) over 3257 resident-months in the control units; adjusted rate ratios were 1.06 (95% CI, 0.92–1.23) for all ADEs and 1.02 (95% CI, 0.81–1.30) for preventable events (both, P = NS)
Field et al (2009)[25]	1 Long-term care facility; 833 residents in 22 units	Clinical decision-support system designed to improve prescribing for residents with renal insufficiency	12 Months	*Process*: Proportions of dose alerts (for which the final drug orders were appropriate) were similar between the intervention and control units (RR = 0.95; 95% CI, 0.83–1.1; P = NS); proportion of maximum frequency alerts (RR = 2.4; 95% CI, 1.4–4.4; $P < 0.05$), alerts for drugs that should be avoided (RR = 2.6; 95% CI, 1.4–5.0; $P < 0.05$), and alerts to acquire missing information (RR = 1.8; 95% CI, 1.1–3.4; $P < 0.05$) for which the final drug orders were appropriate were significantly higher in the intervention group than in the control group
Clinical pharmacy				
Crotty et al (2004)[26]	85 Long-term care facilities; 110 residents	Addition of a pharmacist transition coordinator for the transfer from hospital to	8 Weeks	*Process*: Intervention not associated with a significant change in MAI score from baseline (mean, 3.2; 95% CI, 1.8–4.6 at

Trial	Randomization	Intervention	Duration of Intervention	Results*
		long-term care facility, including medication-management transfer summaries from hospitals, timely coordinated medication reviews by accredited community pharmacists, and case conferences with physicians and pharmacists		baseline vs 2.5; 95% CI, 1.4–3.7 at 8 weeks); however, MAI score worsened in the control group (mean, 3.7; 95% CI, 2.2–5.2 vs 6.5; 95% CI, 3.9–9.1; $P = 0.007$, for comparison between intervention and control mean scores at 8 weeks) *Outcomes*: Intervention group showed a significant protective effect of the intervention against worsening pain (RR = 0.55; 95% CI, 0.32–0.94; $P = 0.023$) and hospital usage (RR = 0.38; 95% CI, 0.15–0.99; $P = 0.035$), but did not differ significantly from control residents in terms of ADEs (RR = 1.05; 95% CI, 0.66–1.68), falls (RR = 1.19; 95% CI, 0.71–1.99), worsening mobility (RR = 0.39; 95% CI, 0.13–1.15), worsening behaviors (RR = 0.52; 95% CI, 0.25–1.10), or increased confusion (RR = 0.59; 95% CI, 0.28–1.22)
Zermansky et al (2006)[27]	65 Nursing homes; 661 residents	Clinical medication review by a pharmacist with patient and clinical records	6 Months	*Process*: Mean number of drug changes per resident was 3.1 for the intervention group and 2.4 for the control group ($P < 0.001$); 75.6% (565/747) of pharmacist recommendations were accepted by the GP; 76.6% (433/565) of the accepted recommendations were implemented *Outcomes*: Mean number of falls per resident was 0.8 for the intervention group and 1.3 for the control group ($P < 0.001$); no significant differences were found in GP consultations per resident (mean, 2.9 and 2.8), hospitalizations (mean, 0.2 and 0.3), deaths (51/331 [15.4%] and 48/330 [14.5%]), Barthel score (mean, 9.8 and 9.3), SMMSE score (mean, 13.9 and 13.8), number of drugs per resident (mean, 6.7 and 6.9), or cost of drugs per resident (mean, £42.24 and £42.94 [~$62.79 and $63.83 in US$, respectively][38] per 28 days)
Furniss et al (2000)[28]	14 Nursing homes; 330 residents	Active medication review by a pharmacist	8 Months	*Process*: The mean number of drugs prescribed decreased in both the intervention group (5.1 at baseline vs 4.2 at 8 months) and the control group (4.9 at baseline vs 4.4 at 8 months); however, the difference between the 2 groups was not statistically significant *Outcomes*: Deterioration in cognitive function was greater in the intervention group than in the control group (mean MMSE score, 12.5 and 17.1, respectively; P = NS); significantly more behavioral disturbance was reported in the intervention group than in the control group (mean CRBRS score, 19.4 vs 14.5; $P = 0.02$); no significant changes were reported in depression (mean GDS score, 3.86 vs 4.41) or quality of life (mean BASDEC score, 3.77 vs 3.26); the number of deaths was significantly lower in the intervention group during the intervention period (4 vs 14; $P = 0.028$) but not during the study period as a whole (26 vs 28)
Roberts et al (2001)[29]	13 Intervention homes, 905 residents; 39 control homes, 2325 residents	Clinical pharmacy program involving development of professional relationships, nurse education on medication issues, and individualized medication reviews	12 Months	*Process*: Use of BZDs, NSAIDs, laxatives, histamine H_2-receptor antagonists/antacids was significantly reduced in the intervention group compared with the control group (change in number of prescription items/year/1000 residents [trial period minus baseline period], intervention minus control: −875, −239, −451, −285, and −82, respectively; all, $P < 0.05$); no significant

Trial	Randomization	Intervention	Duration of Intervention	Results*
				differences in the use of digoxin or diuretics were noted between the groups (change in number of prescription items/year/1000 residents [trial period minus baseline period], intervention minus control: −12 and −355, respectively; *P* = NS); overall drug use in the intervention group was reduced by 14.8% relative to the controls (data not reported; *P* = NS) *Outcomes*: No significant changes in morbidity indices or survival rates between the 2 groups
Thompson et al (1984)[30]	1 SNF; 152 residents (139 residents assessed during the study year)	Clinical pharmacist prescribing and monitoring under the supervision of a family practitioner	12 Months	*Process*: Intervention group had a significantly lower mean number of drugs per resident (5.7) than the control group (7.1; *P* = 0.04) *Outcomes*: Intervention group had a lower number of deaths than did the control group (3/67 [4.48%] vs 10/72 [13.89%]; *P* = NS); intervention group had a significantly higher number of residents being discharged to lower levels of care than did the control group (8/67 [11.94%] vs 2/72 [2.78%]; *P* = 0.03)
Multidisciplinary approaches				
Crotty et al (2004)[31]	10 High-level aged-care facilities; 154 residents	Two multidisciplinary case conferences involving the resident's GP, a geriatrician, a pharmacist, and residential care staff to create a medical problem list for the intervention residents	3 Months	*Process*: Medication appropriateness improved in the intervention group (mean change in MAI score, 4.1; 95% CI, 2.1 to 6.1) vs control (0.4; 95% CI, −0.4 to 1.2; *P* < 0.001); significant reduction in the mean MAI score for BZDs in the intervention compared with control group (0.73; 95% CI, 0.16 to 1.30 vs −0.38; 95% CI, −1.02 to 0.27, respectively; *P* = 0.017) *Outcomes*: Resident behaviors were unchanged after the intervention
Ulfvarson et al (2003)[32]	9 Nursing homes; 80 residents	Medication reviews by a specialist in clinical pharmacology and a specialist in cardiology	3 Months	*Process*: Intervention led to changes in drug therapy for 40 residents; advice was followed by the responsible physician for 19 residents *Outcomes*: No significant changes from baseline to follow-up were found in the mean total scores of any questionnaire (ie, symptoms related to heart failure, adverse reactions to cardiovascular drugs, quality of life, activities of daily living)
Multifaceted approaches				
Colón-Emeric et al (2007)[33]	67 Nursing homes; 606 residents	6-Pronged intervention: continuing-education modules, reminders, audit and feedback, academic detailing, case-based teleconferencing, and an osteoporosis toolkit	6 Months	*Process*: No significant improvements observed in any of the quality indicators; use of osteoporosis pharmacotherapy or hip protectors improved by 8.0% in the intervention group and 0.6% in the control group; completion of the educational module (OR = 4.8; 95% CI, 1.9–12.0; *P* = 0.001) and direct physician contact by an academic detailer (OR = 4.5; 95% CI, 1.1–18.2; *P* = 0.03) were significantly associated with prescribing osteoporosis pharmacotherapy
Loeb et al (2005)[34]	24 Nursing homes; 4217 residents (with outcomes measured)	Diagnostic and treatment algorithm for UTIs implemented at the nursing home level, using small group interactive session for nurses, videotapes, written material, outreach visits, and one-on-one interviews with physicians	12 Months	*Process*: Fewer courses of antimicrobials for suspected UTIs per 1000 resident-days were prescribed in the intervention nursing homes than in the usual-care homes (1.17 vs 1.59 courses; weighted mean difference, −0.49; 95% CI, −0.93 to −0.06; *P* < 0.05); proportion of total antimicrobials prescribed for suspected UTIs in the intervention homes was significantly lower than in the

Trial	Randomization	Intervention	Duration of Intervention	Results*
				usual-care homes (28% vs 39% of antimicrobial courses; weighted mean difference, −9.6%; 95% CI, −16.9% to −2.4%; $P < 0.05$) *Outcomes*: No significant differences found in hospital admissions or mortality rates between the study arms

BZD = benzodiazepine; APAP = acetaminophen; UTI = urinary tract infection; OR = odds ratio; RR = relative risk; SSRI = selective serotonin reuptake inhibitor; SNF = skilled nursing facility; NHAP = nursing home acquired pneumonia; ADE = adverse drug event; MAI = Medication Appropriateness Index (range, 0–18); GP = general practitioner; SMMSE = Standardized Mini-Mental State Examination (range, 0–30); MMSE = Mini-Mental State Examination (range, 0–30); CRBRS = Crichton-Royal Behaviour Rating Scale (range, 0–31); GDS = Geriatric Depression Scale (range, 0–15); BASDEC = Brief Assessment Schedule Depression Cards (range, 0–21).

*Process measures of appropriate prescribing and patient health outcomes.