Chapter 18. Medication Management of the Community-Dwelling Older Adult

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Background

For many older adults, the ability to remain independent in one's home depends on the ability to manage a complicated medication regimen. Nonadherence to medication regimens is a major cause of nursing home placement of frail older adults.[1] In the United States, an estimated 3 million older adults are admitted to nursing homes due to drug-related problems at an estimated annual cost of more than $14 billion.[2] Older adults are the largest users of prescription medication, yet with advancing age they are more vulnerable to adverse reactions to the medications they are taking. Approximately 30 percent of hospital admissions of older adults are drug related, with more than 11 percent attributed to medication nonadherence and 10–17 percent related to adverse drug reactions (ADRs).[3–5] Older adults discharged from the hospital on more than five drugs are more likely to visit the emergency department (ED) and be rehospitalized during the first 6 months after discharge.[6] Nursing interventions that assist older adults in managing their medications can help prevent unnecessary, costly nursing home admissions, hospitalizations, and ED visits, as well as improve their quality of life.

The purpose of this review was to identify evidence-based interventions related to medication management and the community-dwelling older adult. The focus of this review was interventions that fall within the scope of practice of the registered nurse. The guidelines do not address the specific intervention of medication prescribing. However, the interventions are applicable to professional nurse providers whether they are prescribing or not. This chapter discusses risk factors for problems in medication management followed by evidence-based interventions in areas of medication reconciliation, medication procurement, medication knowledge, physical ability, cognitive capacity, intentional nonadherence, and ongoing monitoring.

Risk Factors

There is a wide variety of factors that place the community-dwelling older adult at risk for problems in medication management. The young-old (ages 66–74) have been found to be more adherent to medication regimens than middle-aged older adults, but after age 75, older adults present decreased comprehension of medication instructions and adherence.[7–15] Living arrangements influence the older person's ability to manage medications, and older adults who live alone were found to be more prone to medication errors.[16–21] It is postulated that this is related to the fact that there is no one to monitor, assist, or remind the older person about taking their medications. Persons with chronic disease, especially depression, have a higher incidence of nonadherence to their medication regimen.[7, 10, 22–30] Many of the risk factors related to inadequate medication management are items that are more prevalent in older adults living in the community. Other factors that will be discussed in more detail later in the chapter are physical impairments such as poor vision, grip strength, and cognitive decline.

Older adults are more prone to adverse events due to the clinical complexity of their care rather than age-based discrimination.[31] A study of older adult outpatients who took five or more medications found that 35 percent experienced adverse drug events.[32] In addition, individuals with complex regimens had difficulty naming and explaining the purposes of medications and appeared to be at high risk for nonadherence.[33] The greater the medication complexity, the less likely the older adult is to adhere to the medication regimen.[34] The larger the number of medications, the more likely the older adult will be nonadherent.[3, 9, 13, 19, 28, 35–46] It is not only the number of medications but also the number of doses per day and actions related to taking medications that contribute to complexity of a medication regimen.[34] In a study of medication compliance, the compliance rate was 87 percent for daily dosing, 81 percent for twice a day, 77 percent for three times a day, and 39 percent for four times a day.[47] In addition, a change in prescribed drug regimen has been found to be a predictor of medication nonadherence in older adults.[9] Finally, the number of prescribing providers adds to the complexity of managing one's medications, and persons with more than one prescribing provider were found to be prone to medication errors.[16, 19]

Research Evidence

Medication Reconciliation

Medication reconciliation is the first step in assisting older adults in the medication management process. Multiple studies have demonstrated discrepancies from 30 percent to 66 percent in what medications were ordered by the prescribing provider and the actual medications the older adult was taking.[16, 48–52] Prescribing providers were often unaware of prescribed medications their patients were taking,[16, 53–55] and the larger the number of prescribing providers, the greater the chance of medication discrepancies.[3, 42, 56, 57] A study of elderly patients 2 days after hospital discharge found 64 percent were taking at least one medication that was not ordered, 73 percent failed to use at least one medication according to instructions, and 32 percent were not taking all drugs ordered at discharge.[58] Another challenge in reconciliation of medications is determining exactly what medications older adults are taking in their home. One study found 49 percent of community-based older adults kept stores of old medications from the year before, and 6 percent admitted they self-prescribed medications on at least one occasion.[59] Over the counter (OTC) medication use also needs to be assessed, because estimates of older adults' use of OTC drugs range from 32 percent to 86 percent.[60–62] A recent study of older adults with hypertension attending a blood pressure clinic found 86 percent reported two or more self-medication practices using OTC drugs that could result in an adverse drug interaction.[63]

Multiple studies have demonstrated that 10–74 percent of medications prescribed for older adults were inappropriate.[48, 57, 64–74] A study of "brown bag" medication reviews, in which patients bring all of their medications with them (often in a brown paper bag) to a medical or pharmacy consultation, revealed that 12 percent of the patients had medication problems that could potentially result in hospital admission.[75] A review of ED visits of patients 65 years and older found 10.6 percent of the visits were related to an adverse drug event, and 31 percent had at least one potential adverse drug interaction in their medication regimen.

Pharmacy reviews have demonstrated a reduction in polypharmacy in older adults and decreased adverse drug events in older patients.[76–82] Beer's set of criteria for potentially inappropriate medication use in older adults is one example of criteria developed for pharmacy

screening.[83, 84] There are a variety of drug interaction programs that quickly identify adverse drug interactions.

Also, patients who were given a medication card with a list of current medications were more compliant with their medication regimen.[85] Use of a medication list that is shared with the patient's primary care physician decreased patient rehospitalizations in one study.[86]

Medication Procurement

Not filling or refilling prescriptions is a common cause for medication nonadherence in older adults.[87–91] In a study of elderly patients at 15 days posthospitalization, 27 percent had not filled their new prescriptions.[92] Patients who participated in programs that provided pharmacy delivery and refill reminders had fewer adverse drug events and higher compliance than those who did not.[78]

If the cost of medication is viewed as high, older adults are more likely to not adhere to their medication regimen and be hospitalized.[3, 11, 56] Lack of funds, especially at the end of the month, is one reason older adults delay filling prescriptions.[93] In addition, chronically ill older adults are more likely to experience financial burdens associated with covering out-of-pocket costs for their prescription medications, cut back on medications due to cost, and use less medicines monthly.[89, 93–98] A study of use of medications after an increase in the copayment found a reduction in use of up to 45 percent in nonsteroidal anti-inflammatory drugs and 23 percent in antidiabetic drugs.[99]

Older adults who have insurance to cover medications have greater adherence.[12, 14, 19, 100] In one study, both adherence to medications and clinical outcomes improved while the number of hospitalizations declined when cardiovascular drugs were provided to indigent patients who could not afford to buy them.[101]

Medication Knowledge

Studies of older adults' knowledge of medications have found more than 50 percent knew the names and purpose of their medications; however, less than 25 percent knew the consequences of drug omission or toxic side effects.[9, 16, 54, 102] For example, one study of elderly patients with congestive heart failure found that 30 days after a new medication was prescribed, only 64 percent of the patients could identify when they were supposed to take their medicine.[103] Also, older adults were found to have insufficient knowledge of inhaler technique and understanding how medications can improve their asthma.[104] Noncompliant patients on anticoagulant therapy were more likely to report they did not know why their medication was prescribed.[105] In a study of OTC medication use, few older adults knew precautions related to the OTC drugs they were taking.[61] One study of older adult medication knowledge found that older adults understood prescribed medications better than OTC drugs, especially nutritional supplements.[106]

Patient education is a key intervention to assist older adults with medication management. Patient knowledge of drugs is positively associated with adherence.[16, 21, 91, 105, 107–112] However, older adults require specific educational methods. Learning is more effective in older adults if information is explicit, organized in lists, and in logical order. Instructions that are compatible with the older adults' schema for taking medications are better remembered,[113] and well-organized prescription labels are more useful for older adults.[114] Pictures are not helpful unless the picture is clearly related to the content.[115–118] A combination of both oral and written formats was identified by older adults as most helpful.[119] Medication schedules or charts in combination with teaching or counseling enhances patient medication adherence.[85, 86, 120–124] Four weeks after

starting a new medication for a chronic illness, patients identified a substantial need for further information.[125] Studies have demonstrated that patient education and counseling over several home visits or with followup phone calls produces increased medication adherence in recipients.[126–141]

Physical Ability

Poor vision and low manual dexterity are associated with poor medication self-management.[9,21,39,142–144] The inability to read medication labels has been associated with nonadherence to long-term medications in the elderly.[43,145] One study found 28 percent of community-based older adults did not keep their medication bottles properly closed so that they could open them, and 47 percent admitted that labels on their medications were unclear and they could not read them due to poor eyesight, inability to read English, or small writing on the label.[59] Studies have demonstrated that from 31 percent to 64 percent of older adults living at home have difficulty opening medication containers, with childproof containers presenting the most difficulty.[9,144,146] In studies of persons with chronic obstructive pulmonary disease (COPD), 38 percent used their inhaled medications with poor technique,[89] and poor hand strength was associated with nonadherence in inhaler use.[147] In another study of COPD patients, more than 50 percent had difficulties with their inhalers.[112]

Medication-container modification is one area of intervention for older adults who have difficulty opening or reading containers. Use of nonchildproof containers is one option for older adults. However, blister packs or other variations of unit dose packaging have resulted in increased compliance.[148–150] In a recent study of older adults, 64 percent were unable to open childproof containers, and 10 percent were unable to use blister packs.[9] Also, different tablet formations that increase the ease of breaking tablets have been found to increase patients' abilities to comply with their medication regimen.[151] Finally, talking medication containers and large-print labels are modifications that can be useful for persons with visual impairment.

Cognitive Capacity

Poor cognition is associated with both over adherence and under adherence of a prescribed medication regimen.[9,14,18,28,37,38,142–144,152–155] A study of community-dwelling women found that 22 percent were unable to accurately perform a routine medication regimen; however, only 2 percent self-identified that they had difficulty with their medications.[156] Forgetting is a major reason medication doses are missed.[9,78,88,89,157–162] The most prominent type of medication noncompliance is dose omission, but overconsumption is a common mistake, especially in persons on a once-daily dose schedule.[163]

There are a number of interventions to assist older adults with remembering to take their medications. One simple method is the use of memory cues that prompt patients to take their medications.[148] Development of memory cues must be tailored to the patient's lifestyle.[90,164] Placing medication in a special place and use of a daily event such as meal time improve medication adherence.[91,106,165,166] A study that examined the most common ways older adults remembered to take their medications found the following methods to be beneficial: (1) placing containers in a particular location, (2) taking medications in association with meals/bedtime, (3) using a timed pill box, (4) reminders from another person, and (5) using written directions or a check-off list.[159]

Compliance aids such as pill box organizers have been found to increase medication adherence.[16,78] Medication schedules and calendars are helpful, especially in combination with education and use of a pill box.[38,40,78,120,150,167,168] In addition, electronic monitoring that provides feedback to the user increases adherence.[141,169–171] Older patients using a voice-reminder-message medication dispenser were significantly more compliant than those using a pill box or self-administering medications.[172,173] Patients using topical pilocarpine were significantly more compliant using an electronic medication alarm device.[174] Programs that use daily telephone reminder calls also have demonstrated increased medication compliance.[155,175] Several studies have demonstrated that dose simplification from two times a day to one time a day produces higher compliance and improved patient outcomes.[122,176–182]

Intentional Nonadherence

One study of chronically ill persons who were starting a new medication found that almost a third did not take their medication as prescribed, and half of the time it was deliberate.[125] Older adults' perceptions of the seriousness of their illness and vulnerability to complications were significantly related to medication adherence.[13,46,90,91,97,166,183] In fact, low self-efficacy and beliefs that others are responsible for one's health care are predictors of medication nonadherence.[21,89,105,159,184–194]

A major reason that older adults skip doses or stop taking their medications is related to medication side effects.[9,11,16,26,38,46,89,91,93,110,125,159,161,162,191,195–198] In a comparison of compliant and noncompliant patients in fluvastatin treatment, the noncompliant patients were more likely to experience side effects of the medication.[199] Six months after discharge for acute coronary syndrome, 8 percent of those taking aspirin,12 percent of those taking beta-blockers, 20 percent of those taking ACE inhibitors, and 13 percent of those taking statins had discontinued taking their medications.[200]

Use of commitment-based interventions has been found to increase self-efficacy and medication compliance.[201] Education that addresses patient involvement with decisionmaking, such as focusing on appropriate versus inappropriate use of medication, can improve self-efficacy.[202] Patients with depression who participated in a program to enhance self-management and prevent relapse had significantly greater long-term adherence to their medication regimen.[203] Patients whose provider had an open, collaborative communication style also were more adherent to their medication regimen.[204]

Ongoing Monitoring

Older adults have narrow therapeutic windows and require close monitoring, especially when on multiple medications.[205] Ongoing monitoring of the older adult's medication management is critical. A study of home care patients found 16 percent had skipped a medication in the last 24 hours, 6 percent were taking the wrong dose, and 5 percent were experiencing adverse effects from their medication.[87] In one study, symptomatic hypotension was identified in 13 percent of community-based elderly.[67] In another study, older adults treated for urinary tract infections and sleeping disorders experienced a significantly higher risk of ADRs.[206] A review of ED visits of patients 65 years and older found 10.6 percent of the visits were related to an adverse drug event, and 31 percent had at least one potential adverse drug interaction in their medication regimen.[207] Pharmacist management of repeat prescriptions found 12.4 percent of patients had compliance

problems, side effects, ADRs, or drug interactions.[208] A total of 35 percent of elderly ambulatory patients reported at least one adverse event within the previous year.[209]

Monitoring medication adherence is an ongoing process. The longer people are on a medication, the more likely they are to have difficulty following the medication regimen.[179, 210] For example, in one study, only 31 percent of people with type 2 diabetes who were on oral hypoglycemics adhered to their medication regimen.[211] In another study, persons on oral hypoglycemic medications were nonadherent an average of 64.7 days in one year.[212] Since adherence to medication regimen for type 2 diabetes is strongly associated with metabolic control, interventions related to monitoring and improving adherence are critical.[213]

Patients taking Digoxin who are not adherent have an increased number and duration of hospitalizations and twice the mortality rate than those who are adherent.[214] Also, in a study of long-term compliance of antihypertensive drugs, patients on ACE-inhibitors, beta-blockers, calcium channel blockers, and diuretics were more likely to be noncompliant,[215] as were persons using bronchodilators and benzodiazepines.[60]

Practice-Implications: Medication Management Practice Guidelines

Medication Reconciliation

1. Review with patient all prescribed and nonprescribed medications the patient is taking. Include over-the-counter (OTC) medications, herbs, and vitamins.[216]
2. Screen for adverse drug interactions. If adverse drug interactions are identified, report to the prescribing provider any medications of concern.[76–82,84,216]
3. Identify the primary or secondary medical diagnosis related to each prescribed medication. If the medical diagnosis is unknown, request the diagnosis from the prescribing provider.[84,216]
4. For patients age 65 and older, apply Beer's criteria for inappropriate medication for the elderly. If any medications appear in Beer's criteria, report to the prescribing provider any medications of concern.[84]
5. Provide to the prescribing provider(s) a list of all medications (prescribed and OTC) the patient is taking and a list of corresponding medical diagnoses.[216]
6. Verify prescribed medications and related medical diagnoses with the prescribing provider(s).[84]
7. Provide the patient or caregiver a current list of all medications the patient is taking with dose and frequency; have the patient share this list with the prescribing provider or other health care providers as needed.[85,86,216]

Medication Procurement

1. Assess the patient's or caregiver's ability to procure medications.[87–92]
    a. Identify how and where the patient obtains and refills prescriptions.[87–92]
    b. Assess how the patient pays for medications.[3,11,56]
    c. Assess if medications doses are ever missed due to lack of funds.[93]
2. If the patient or caregiver has difficulty obtaining or refilling prescriptions, assist the patient with creating a system to procure medications via

   a. Pharmacy delivery.[78]
   b. Refill reminders or automatic refill service.[78]
   c. Scheduling family or friends to pick up medications.
3. If funds to purchase medication are a problem,[89,93–98]
   a. Refer the patient to a social worker to obtain Medicare Part D coverage, other insurance coverage, or participation in drug company programs.[12,14,19,99,100]
   b. Consult with the pharmacist regarding use of generic drugs.
   c. Consult the prescribing physician about availability of drug samples.[101]

Medication Knowledge

1. Assess the patient's or caregiver's knowledge of
   a. Dose and frequency of medications taken.[9,16,33,54,102,103]
   b. Special instructions related to medications, such as "take with food."[33]
      i. If the patient uses an inhaler, understanding of the correct inhaler technique.[104]
   c. Medication mode of action.[9,16,54,102]
   d. Side effects to monitor and report.[9,16,54,102]
2. With each change in medication regimen (including OTC drugs), review medication purpose, dosage, frequency, side effects to monitor and report, and other medication-specific instructions.[61]
3. Interventions related to medication knowledge include[16,21,91,105,107–112]
   a. Provide written instructions related to medications in large letters and bullet or list format.[115–119]
   b. Tailor instructions to how the patient takes his or her medicine.[113]
   c. Group information starting with generalized information, followed by how to take the medicine, and then the outcomes such as side effects to watch for and when to call the doctor.[114–118]
   d. Use medication schedules or charts to reinforce instructions.[85,86,120–124]
   e. If the patient did not know important medication information at a previous encounter, review dose, time, side effects to monitor and report, and special instructions at the next visit.[125–141]

Physical Ability

1. Assess for decreased manual dexterity or vision impairment and its affect on the patient's ability to identify the correct medication, open medication containers, and prepare medications (e.g., breaking tablets) for administration.[9,21,39,43,142–145]
   a. Observe the patient opening medication containers.[9,59,144,146]
   b. If the patient uses an inhaler, observe the use of the inhaler.[89,112,147]
   c. If the patient is required to break tablets, assess his or her ability to do so.[151]
   d. If the patient is unable to open or see the label and contents of each medication container, provide one of the following:
      i. Pill box or other easy-open container.[150,172,217] If the patient is unable to fill the pill box, identify someone who can assist him or her.
      ii. Medication calendar with pill box.[155,167,168,218]
      iii. Blister packs.[138,149] Consult the pharmacy about the availability of the drug in blister packs or nonchildproof containers.

iv. If tablet breaking is required and the patient has difficulty doing it, consult with the pharmacist about tablets that are easier to break or tablets that are the correct dosage without requiring breaking.[151]

Cognitive Capacity

1. Assess the patient's or caregiver's cognitive capacity to organize and remember to administer medication.[106, 156]
    a. Assess when doses are taken.
    b. Assess what cues the patient uses to remember to take medication.
    c. Assess what dose is most difficult to remember.[9,78,88,89,157–162]
    d. Assess how often a dose is missed or an extra dose is taken.[9,14,18,28,37,38,142–144,152–155]
2. Teach the patient or caregiver the use of memory cues based on one of the following methods:[148,159]
    a. Clock time. Ask if the patient or caregiver is usually aware of the time of day or keeps track of time through a watch or clock.
    b. Meal time.[90,91,106,164–166] Ask if the patient eats meals at a regular time.
    c. Daily ritual, such as using the bathroom in the morning, shaving, or hair combing.[90,91,106,164–166]
3. If the patient requires additional support,
    a. Provide memory-enhancing methods or devices such as
        i. Medication calendar or chart.[38,40,78,120,150,167,168]
        ii. Electronic reminder or alarm.[141,169–171,174]
        iii. Voice-message reminder.[172,173]
        iv. Telephone reminder.[155,175]
        v. Pill box.[16,78] (If the patient is unable to fill a pill box, identify someone who is willing to assist him or her.[158])
        vi. Electronic medication dispensing device.[173]
        vii. Combine methods and devices when possible.[38,40,78,120,150,167,168]
    b. Discuss dose simplification with the prescribing provider.[122,176–182]

Intentional Nonadherence

1. Assess if medication doses are missed intentionally.[125]
    a. Drugs at high risk for intentional noncompliance include the following:
        i. ACE-inhibitors[200,215]
        ii. Beta-blockers[200,215]
        iii. Calcium channel blockers[200,215]
        iv. Diuretics[215]
        v. Bronchodilators[60]
        vi. Benzodiazepines[60]
    b. If the patient intentionally misses doses, assess the reason(s).
        i. Belief medication is not helping.[13,46,90,91,97,166,183]
        ii. Fear of adverse side effects.[13,46,90,91,97,166,183]
        iii. Side effects.[9,11,16,26,38,46,89,91,93,110,125,159,161,162,191,195–198]

   c. The following medications are most risky for patients to miss:
      i. Coumadin[105]
      ii. Digoxin[214]
      iii. Beta-blockers[200]
      iv. Insulin
      v. Prandinm® (repaglinide)
      vi. Antibiotics
      vii. ACE-inhibitors[200]
2. If the patient misses medication doses for reasons related to health beliefs,
   a. Explore with the patient his or her health concerns for not taking medication.[202]
   b. Discuss the benefits of taking medication as prescribed.[202]
   c. Provide positive reinforcement for taking medication as prescribed.[201]
3. For patients on high-risk medications, reinforce the danger of missing medication doses.[105]
4. If the patient misses medication doses for reasons related to medication side effects,
   a. Explore with the patient a plan to manage the side effects.[203]
   b. Modify the regimen to reduce the side effects.

Ongoing Monitoring

1. For all patients on a prescribed medication regimen, monitor the patient with each encounter for the following:
   a. Medication adherence
      i. Monitor both under- and overadherence.[87,179] Overconsumption occurs frequently in a once-daily dose schedule.
      ii. For persons using inhalers, assess
         1. Inhaler emptying rate.[89,104,147]
         2. Reported forgetfulness.[104]
         3. Use of short-acting inhaler.[89,104]
   b. Medication side effects[67,205]
      i. If medication side effects present, notify the prescribing provider, as appropriate.
   c. Lab work, as appropriate, for prescribed medications[216]
      i. Cockcroft-Gault Formula or other creatinine clearance measure at least annually. If creatinine clearance <50 ml/min, notify the prescribing provider.
   d. Medication effectiveness[205]
      i. If signs and symptoms of the problem the medication is treating are present, notify the prescribing provider, as appropriate.

Research Implications

There is a large volume of research related to medication management and the elderly. Medication management is a complex process that must be interdisciplinary in its approach. Many of the evidence-based interventions discussed are not discipline specific. A team of providers is needed to provide safe and therapeutic medication management.

There is a large amount of research related to risk factors for medication nonadherence. However, there is less evidence related to appropriate interventions to enhance adherence and medication self-management. In addition, the most effective programs have multiple interventions, so identifying the specific evidence for each intervention component is difficult. For example, one study included a combination of interventions of medication review, modification of containers, medication education, and a drug reminder chart.[138] All are important components of a medication program for older adults, yet it is difficult to identify the evidence supporting each component. What is promising is the use of technology to assist in medication management.[173,219] This includes clinical screening software for adverse drug interaction and potentially inappropriate prescribed medications, electronic adherence monitoring, and electronic medication reminders. Much of this new technology is currently being tested.

Conclusion

Medication management is a complex process that consists of multiple activities. Factors associated with problems in the performance of these activities include living alone, impaired vision, impaired cognitive function, ages 75 and older, having three or more medications and/or scheduled doses in one day, and more than one prescribing provider. Medication reconciliation is a key first step in medication management. Multiple studies have demonstrated large discrepancies in what medications are ordered by the prescribing provider and the actual medications the older adult is taking. Evidence supports medication reconciliation interventions that include a screen for inappropriate medications and adverse drug interactions, in addition to verification of medications that are prescribed. Other areas of medication management include assessment and interventions related to medication procurement, medication knowledge, physical ability, cognitive capacity, and intentional nonadherence. Ongoing monitoring of these areas is crucial.

Nurses play a pivotal role in the medication management process of older adults. Considering the expense of prescription drugs in the current health care system, a small investment in providing comprehensive assessment and interventions to assist older adults in accurate and safe management of their medications will provide cost-effective care and increase the quality of life of older adults struggling to manage their often-complex medication regimens.

Search Strategy

To conduct this review, a search was done in August 2005 of PubMed®, the Cumulative Index to Nursing & Allied Health Literature, Cochrane Database of Systematic Reviews, HealthStar, ISI Web of Science, Social Service Abstracts, Database of Abstracts of Reviews of Effectiveness, and Internet searches for citations occurring from January 1990 to August 2005. Key search terms used alone and in combination included medication adherence, compliance, elderly; aged; outcomes; polypharmacy; medication management; chronic illness; chronic disease; and individual types of chronic illnesses. All searches were limited to patients ages 65 and older and Web sites in the English language. The ISI Web of Science was used to track citations to major works, and article references were reviewed for inclusion. Bibliographies of retrieved articles also were searched for relevant articles not identified in the reference database searches.

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Evidence Table. Medication Management of the Community-Dwelling Older Adult (Includes studies design level 4 and above)

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Allard 2001[220]	Inappropriate prescribed medication	Randomized Controlled Trial (RCT)	1. RCT (Level 2) 2. Error over time (Level 2)	1. Community-dwelling older adults, age > 70 years and taking > 3 drugs 2. Treatment (*n* = 136) • Subgroup received case conference w/ intervention (*n* = 80) 3. Control (*n* = 130)	Medication review by nurse, pharmacist, and physician with monthly nurse followup. Potentially inappropriate prescriptions (PIPs) reported to prescribing physician.	Mean PIPs decreased in treatment group, but not significant.
Andrejak 2000[176]	Medication adherence	RCT	1. RCT (Level 2) 2. Clinical outcome (Level 1)	1. Multicenter: 6 month study, persons 18 and older with essential HTN (diastolic BP,95-115) 2. Mean age 57 3. Two treatment groups: • Twice-daily dosing (*n* = 62) • Once-daily dosing (*n* = 84)	Dose simplification: once a day, group one; twice a day, group two.	Evidence suggests that daily dosing enhances daily compliance, missing fewer doses, and taking medications on time as scheduled by the patient's provider ($P < 0.01$).
Bond 2000[208]	Medication adherence	RCT	1. RCT (Level 2) 2. Adverse events (Level 1)	1. Outpatient general medical clinics (19) 2. Community pharmacies (*n* =62) 3. Two groups: • Treatment (*n* = 904) • Control (*n* = 1,397)	Pharmacists monitored for • compliance • adverse reactions • symptoms • medication problems	The intervention group had more compliance problems identified ($P = 0.001$), while the control group had more items prescribed ($P = 0.003$) and resultant higher prescription costs.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Bonner 2002[53]	Medication compliance	Non-compar-ative study	1. Observational study without controls (Level 5) 2. Surrogate outcome: observed errors (Level 2)	1. Rural general practice older adults (50) 2. Selection: • Random presentation at surgery • > 4 meds • Significant medical history	1. Clinical pharmacist medication screening 2. Physician verification and correction of errors transcribed to a portable medication summary card	40% of subjects noncompliant, 8% of clinical pharmacist's medication issues required a change in therapy, and 18% reported medical information to the clinical pharmacist that the physician was unaware. The use of a medication card summary implemented via clinical pharmacist and physician intervention was ineffective in improving older adult medication compliance.
Bouvy 2003[131]	Medication compliance	RCT	1. RCT (Level 2) 2. Error over time (Level 2)	Heart failure patients treated with loop diuretics in an outpatient heart failure clinic or admitted to participating hospitals • Treatment (*n* = 74) • Usual Care (*n* = 78)	Pharmacist led monthly medication education for 6 months	Medication education decreased the number of missed doses (relative risk 0.33 [CI 95% 0.24–0.38]) and consecutive missed doses (relative risk 0.32 [CI 95% 0.19–0.55]). No significant difference in rehospitalization rate, mortality, and quality of life (QOL).
Cargill 1992[126]	Medication compliance	RCT	1. RCT (Level 2) 2. Error over time (Level 2)	1. Age 60and older 2. Three groups (total *n* = 70) • Control • Education • Education & followup phone call	1. Home visits: medication education, followup phone call 2 weeks s/p medication education 2. Compliance measured via pill count	Followup phone calls & education improved compliance (*P* = 0.0097). Compliance decreased as prescribed medications increased (*P* = 0.0097). Compliance was higher with home visit nurse led medication education with supportive followup.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Coleman 2004[49]	Care transition	Prospective cohort study	1. Non-RCT (Level 3) 2. Adverse events (Level 1)	1. Age 65 and older posthospitalization 2. Two groups: • Treatment (*n* = 158) • Control (*n* = 1,235) from administrative data	1. Medication self-management 2. Patient-centered record 3. Primary care and specialist followup 4. Education of warning signs and symptoms of worsening condition.	Odds ratios comparing rehospitalization 30 days: 0.52 (95% CI = 0.25–0.96), 90 days: 0.43 (95% CI = 0.25–0.72), and 180 days: 0.57 (95% CI = 0.36–0.92). Median time to first rehospitalization decreased (*P* = 0.003). Care transition was effective in decreasing hospital admissions. Intervention patients reported high levels of confidence in care management.
Day 1998[221]	Medication knowledge and compliance	RCT	1. RCT (Level 2) 2. Pretest/post-test (Level 3)	1. Rehabilitation Hospital patients 2. Mean age = 64.8 3. Two groups: • Self-administered medication during hospitalization (*n* = 24) • Nurse-administered medication (*n*=15)	1. Self-administration of medications while hospitalized. 2. Education	No significant differences found between groups. Small sample size.
Detry 1995[181]	Medication compliance	Non-RCT	1. Non-RCT (Level 2) 2. Observed errors (Level 3)	1. Persons treated with slow release nifedipine or amlodipine 2. for at least 4 weeks prior to study inclusion. 3. Mean age = 60 4. Two groups: • crossover at 6 weeks • once a day (*n* = 160) • twice daily (*n* = 160)	Dose simplification: once daily amlodipine versus twice daily slow release nifedipine for 4 weeks	Compliance with once-a-day dosing was higher than twice-daily dosing (*P* < 0.001). No significant difference in BP was identified.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Dezii 2001[177]	Dosing medication compliance	Retrospective cohort study	1. Retrospective cohort comparison (Level 4) 2. Medication errors related over time (Level 2)	1. HTN patients new to therapy 2. Two groups: • Single pill group (n = 969) • Two pill combination group (n = 624)	Dose simplification	Dose simplification to single-pill dosing vs. two-pills dosing significantly increased the persistence with prescribed therapy ($P < 0.05$).
Eisen 1990[182]	Medication compliance	RCT	1. RCT (Level 2) 2. Observed errors over time (Level2)	1. VA medical center clinic HTN patients 2. Three groups: • Once-daily dose (n = 45) • Twice-daily (n = 40) • Three times daily (n = 20)	1. Dose simplification 2. Measurement by electronic blister pack that recorded medication removal.	Once-a-day dosing adherence rate was higher than 3-times-a-day dosing ($P < 0.05$). Compliance increased as number of daily doses decreased.
Esposito 1995[167]	Medication adherence	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Age 65 and older at hospital discharge 2. Four groups: • Group I – standard education (n = 11) • Group II – standard education and 30 minute verbal instructions (n = 8) • Group III – standard education and medication schedule (n = 10) • Group IV – standard education, medication schedule, and 30 minute verbal instructions (n = 14)	Medication schedule with verbal reinforcement.	Higher compliance rates were found in subjects who used medication schedule. Pilot, small study.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Fillet 1999[76]	Polypharmacy	Noncom-parative study	1. Observational study without controls (Level 5) 2. Measurable outcomes with unestablished connection to outcome (Level 3)	1. Medicare managed care organization patients 65 and older on 5 or more medications, over 3 month period. 2. 5,737 identified as high risk and surveyed, with 2,615 responding (response rate = 46%). 3. 275 primary care physicians surveyed, with 56 (20%) responding.	1. Identification of patients at risk for polypharmacy. 2. Empowerment letters sent to patients with brown bag to encourage a primary care provider (PCP) appointment for medication review. 3. All PCPs provided with practice guidelines regarding polypharmacy and patient-specific medication management reports.	17% of patients informed their PCP about a new prescription or nonprescription medication they were taking. The review resulted in medication changes in 51% of the reviews. 29% reported a decrease in frequency of dosing, and 20% had a medication discontinued. 45% of the physicians reported at least one medication change.
Friedman 1996[132]	Medication Adherence	RCT	1. RCT (Level 2) 2. Clinical outcome (Level 1)	1. Persons age 60 and older under treatment for hypertension from community sites such as senior centers with BP>160/90 2. Two groups: • Treatment (n = 133) • Control (n = 134)	1. Automated telephone patient monitoring and counseling. 2. Weekly-treatment subjects reported self-measured BP, knowledge, and adherence to medications and side effects.	Medication adherence was higher (P = 0.03) and diastolic blood pressure lower (P = 0.02) in the treatment group.
Fulmer 1999[175]	Medication compliance	RCT	1. RCT 2. Observed errors (Level 2)	1. Community dwelling, age 65 and older with diagnosis of CHF 2. Three groups: • Control (n = 14) • Telephone (n = 13) • Videophone (n = 15)	1. Telephone group received daily telephone call reminders. 2. Videophone group received daily videophone call reminders.	Control group had lower compliance than the groups who received either videophone or telephone calls (P < 0.04).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Goodyer 1995[123]	Medication compliance	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Outpatient clinic patients 70 years and older with chronic stable heart failure 2. Two groups: • Treatment (*n* = 50) • Control (*n* = 50)	Three month pharmacist-led medication counseling with three home visits	Compliance and medication knowledge were higher in treatment group ($P < 0.001$). Both exercise and distance to breathlessness improved in the treatment group and worsened for controls ($P < 0.01$). No significant changes were noted in Nottingham Health profile.
Hawe & Higgins 1990[222]	Medication compliance	Non-RCT	1. Nonrandomized control trial (Level 3) 2. Errors over time (Level 2)	1. Inpatient persons age 55 and older 2. Two groups assigned by month of admission: • Treatment (*n* = 149) • Control: received dummy intervention (*n* = 119)	1. Group-based inpatient educational session followed by individual pharmacist predischarge instruction and individual medication record card. 2. Measurement: • Compliance by subject report • Interviews 1 month and 3 months postdischarge	No significant difference in compliance at 1 and 3 months; however, the program was effective in a subgroup of persons taking four or more drugs, with the treatment group compliance rate at 55% versus the control at 32% at 3 months.
Hanlon 1996[77]	Inappropriate medications	RCT	1. RCT 2. Adverse events (Level 1)	1. Patients 65 and older of a general medical VA clinic 2. Two groups: • Treatment (*n* = 105) • Control (*n* = 103)	1. Pharmacist met with patients during scheduled clinic visits evaluating drug regimens. 2. Recommendations made to prescribing physician.	Inappropriate prescribing lower in treatment group ($P = 0.0006$), fewer ADRs in intervention group ($P = 0.19$).
Hayes 1998[117]	Medication knowledge	RCT	1. RCT (Level 2) 2. Knowledge post-test (Level 3)	1. Patients discharged from three rural emergency departments, age 60 and older. 2. Two groups: • Treatment (*n* = 30) • Control (*n* = 30)	Geragogy-based medication instruction sheets	Utilization of Geragogy-based medication instruction sheets increased patient knowledge of medications ($P = 0.16$).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Huang 2004[135]	Medication education	Non-RCT	1. Nonrandomized control trial (Level 3) 2. Clinical outcomes (Level 1)	1. Patients of district health center, 65 and older, diagnosed with diabetes mellitus, living alone, with resting BP less than 160/100 mmHg. 2. Matched on age, sex, education, and history of diabetes. 3. Three groups: • Group 1 – home-based nursing (*n* = 15) • Education program (*n* = 15) • Control (*n* = 14)	1. Group 1 – daily nurse visits to supervise diet, exercise, medication, and self-monitoring blood sugar. 2. Group 2 – weekly nurse visits to supervise diet, exercise, medication, and self-monitoring blood sugar. Nursing weekly home visits vs. daily home visits.	Both intervention groups had reductions in blood sugar and HGA1c ($P < 0.001$), cholesterol, & LDL ($P < 0.05$). Subjects with daily nurse visits had greater weight loss ($P < 0.05$).
Kimberlin 1993[82]	Medication compliance and knowledge	Non-RCT	1. Nonrandomized trial (Level 3) 2. Adverse events (Level 1)	1. Subject criteria • Age 60 or older • Capable of self-care • Taking four or more medications or medications from a list of targeted drugs with narrow therapeutic ranges or likely to cause problems in the elderly. 2. Two subject groups: • Treatment (*n* = 410) • Control (*n* = 352) 3. Pharmacist assignment to treatment (n = 55) or control (n = 33).	Intervention pharmacists participated in home study and 1-day workshop on drug therapy for elderly patients.	Subjects of intervention pharmacists more likely to report pharmacists provided information and assessed for problems than were control subjects. No significant differences were found in compliance or hospitalizations. However, the addition of each medication in the drug regimen elevated the odds of a subject reporting a problem with med therapy by 1.115.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Krska 2001[81]	Medication review	RCT	1. Group RCT (Level 2) 2. Errors over time (Level 2)	1. Community-dwelling older adults • Age 65 or older • Four or more medications • At least two chronic conditions 2. Two groups: • Treatment (*n* = 168) • Control (*n* = 164)	Pharmacist medication review with pharmaceutical care plan with medication regime changes in collaboration with general practitioner.	All subjects reviewed had at least two PCIs, and a greater number were resolved at followup in the intervention group. No significant difference was found in quality of life or cost between groups.
Leirer 1991[155]	Medication adherence	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Community-dwelling older adult volunteers • Mean age 70.9 2. Excluded cognitively impaired, depressed, debilitating conditions, or taking two or more medications. 3. Two groups: • Treatment (*n* = 8) • Control (*n* = 8)	1. Both groups given medication schedule and portable bar code reader to record simulated medication taking for 1 week. 2. Treatment group received voice mail reminders.	Voice mail reminders enhanced medication adherence ($P = 0.03$), memory failure contributes to medication nonadherence ($P = 0.05$).
Lipton 1994[80]	Medication compliance and resource utilization	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Geriatric hospitalized patients on three or more medications at discharge. 2. Two groups: • Treatment (*n* = 350) • Control (*n* = 356)	Pharmacist-led drug consultation service at hospital discharge, 1 week, 2–4 weeks, 2 months, and 3 months postdischarge via phone (85%) or home visit. Followup phone calls.	Pharmacist consultation decreased medication complexity ($P < 0.001$), number of medications ($P < 0.001$), and average daily doses ($P = 0.02$) at 3 months. Medication compliance, missed doses, and knowledge were impacted the greatest at 3 months ($P < 0.001$). No significant difference in health care use or charges were identified.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Lourens 1994[85]	Medication compliance	RCT	1. RCT (2) 2. Errors over time (Level 2)	1. Outpatient clinic (mean age 72) 2. Two groups: • Counseling only (*n* = 49) • Counseling and medication card (*n* = 48)	1. Pharmacist counseling both groups. 2. Written medication card in treatment group.	Subjects with written medication card had both higher knowledge increased compliance (*P* < 0.001).
Lowe 1995[223]	Medication compliance	Prospective cohort study	1. Nonrandomized control trial (Level 2) 2. Errors over time (Level 2)	1. Hospitalized older adults (mean age 79) 2. Two groups: • Treatment (*n* = 42) • Control (*n* = 37)	1. Inpatient self-medication management program 2. Education	Both compliance (*P* = 0.02) and medication knowledge (*P* < 0.001) were higher in the self-medication management group.
Lowe 2000[138]	Medication compliance	RCT	1. RCT (Level 2) 2. Errors over time (Level2)	1. Community-dwelling older adults, > 65, taking three or more medications 2. Two groups: • Intervention (*n* = 73) • Control (*n* = 79)	Pharmacist-led Intervention that included • Medication review and verification with PCP • Modification of medication containers • Medication education • Drug reminder chart	Medication review, verification, education, and modification of containers increased medication compliance (*P* < 0.0001) and medication knowledge (*P* < 0.0005).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Malone 2001[224]	Optimizing medication therapy	RCT	1. RCT (Level 2) 2. Clinical outcome (Level 1)	1. Older adult ambulatory veterans (mean age = 66.8) who were high risk for drug-related problems. 2. High risk defined as having three or more of the following criteria: • 5 or more medications • 12 or more daily doses • 3 or more chronic conditions • 4 or more changes to drug regimen over past year • Taking less than 80% of prescribed medications • On medications that require monitoring 3. Two groups: • Treatment (n = 523) • Control (n = 531)	1. Intervention subjects received a minimum of three ambulatory clinical pharmacist in-person visits or phone calls. 2. Intervention protocol included • Physical assessment: • Compliance monitoring • Lab monitoring • Drug screening • Identifying untreated diseases • Referrals to primary care and specialist physicians	Clinical pharmacist-led intervention had no effect on HRQOL. Change in health status declined less in treatment (P < 0.004), but was not clinically meaningful. Intervention dose-response relationship for general health perceptions (P < 0.004), vitality (P < 0.006), and change of health over the past year (P < 0.007) was found.
McKenney 1992[171]	Medication compliance	RCT	1. RCT (Level 2) 2. Clinical outcome (Level 1)	1. Ambulatory patients from retirement community or primary care center 2. Age 50 or older 3. Treated for HTN for 12 months 4.Four groups	1. Group A (n = 17): control 2. Group B (n = 18): timepiece cap as stimulant strategy 3. Group C (n = 18): timepiece cap + pocket-size BP recorder 4. Group D (n = 17): timepiece cap + pocket-size BP recorder + BP cuff for self-monitoring	Timepiece cap used alone improved compliance significantly (P < 0.01) and lowered mean SBP/DBP lower (P < 0.01). The addition of blood pressure reporting card and home blood pressure monitoring increased compliance and reduced BP (P < 0.01).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Meredith 2002[79]	Inappropriate prescribing	RCT	1. RCT (Level 2) 2. Clinical outcomes (Level 1)	1. Newly admitted Medicare home health care patients 2. Selection criteria • At least 4 weeks of skilled service • At least one medication problem • Age 65 and older 3. Two groups: • Treatment (*n* = 130) • Control (*n* = 129)	Medication improvement program • Screen for duplication, cardiovascular issues, use of psychotropics, and NSAIDs. • Medication use plan discussed directly with prescribing physician by home care nurse.	Intervention improved medication use in 12 patients per 100 (95% CI = 0.0–24.0, *P* = 0.051), by decreasing medication duplication in 47 patients per 100 (95% CI = 20–74, *P* = 0.003), and improvement of the use of cardiovascular drugs in 37 patients per 100 (95% CI = 9–66, *P* = 0.17). No significant changes in clinical outcomes of general health (SF-36, cognitive impairment (MMSE) and ADLs.
Murray 1993[150]	Medication compliance	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Persons 60 and older living in urban public housing for older adults on at least three medications 2. Three groups: • Group 1 (*n* = 12): conventional packaging, varied dosing • Group 2 (*n* = 10): conventional packaging and BID dosing • Group 3 (*n* = 9): unit-of-use packaging and BID dosing	Unit-of-dose packaging: single cup holding all meds to be taken at dosing time and BID dosing	Compliance in older adults was higher with dose simplification and unit-of-dose packaging (*P* = 0.017).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Naunton 2003[78]	Medication compliance	RCT	1. RCT (Level 2) 2. Adverse events (Level 1)	1. Community-dwelling older adults age 60 and older on four or more medications 2. Two groups: • Intervention (*n* = 57) • Control (*n* = 64)	1. Pharmacist home visit 5 days after hospital discharge included medication review, compliance encouragement, education, intervention when appropriate, with communication to community providers. 2. Followup at 90 days.	Intervention group had a median of three drug-related problems at 5-day visit and had declined to one problem at 90 days, compared to two problems for the control group ($P < 0.0001$). Intervention group unplanned rehospitaliztions were lower ($P < 0.0001$) and compliance higher ($P < 0.0001$).
Park 1992[168]	Medication adherence	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Community-dwelling older adults • Taking two or more medications • Age 60 or older 2. Four groups: • Control (*n* = 16) • Medication schedule chart (*n* = 15) • Medication organizer (*n* = 15) • Schedule and organizer (*n* = 15)	Use of medication schedule and organizer compliance devices	Omission errors were the lowest in the group that used both schedule and medication organizer. Adults ages 71 and older had a lower rate of adherence (85%) than adults ages 60–70 (94%).
Patton 1997[128]	Medication adherence	Pre- and post-test	1. Nonrandomized control study (Level 3) 2. Clinical outcomes (Level 1)	1. HMO clinic patients with SBP 145 or greater and DBP 85 or higher consistently for at least 6 months. 2. Total subjects = 107 3. Median age 69	1. Nurse interactive education with written information. 2. Followup phone calls at 1, 3, 6, and 12 months after initial education.	Medication education with telephone followup decreased SBP/DBP ($P < 0.01$). Older adults had a greater reduction in BP ($P = 0.01$).
Pereles 1996[225]	Medication compliance and knowledge	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Geriatric rehabilitation inpatients 2. Two groups: • Treatment (*n* = 51) • Control (*n* = 56)	Inpatient program that included three stages of increasing responsibility to independently self-medicate.	Treatment group at 1 month had fewer self-medication errors than control ($P < 0.001$). No difference between groups in knowledge, morale.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Perri 1995[170]	Medication compliance	Non-RCT	1. Non-RCT (Level 3) 2. Errors over time (Level 2)	1. Community-dwelling pharmacy customers taking a chronic medication with a new refill or prescription 2. Two groups: • Intervention (*n* = 88) • Control (*n* = 98)	Stimulant "counter cap" prescription vile that indicates when cap was last opened.	Subjects using the counter cap had improved medication compliance (*P* = 0.0366).
Piette 2000[129]	Medication adherence	RCT	1. RCT (Level 2) 2. Clinical outcomes (level 1)	1. Adults receiving diabetes treatment at a county health clinic 2. Mean age 56 3. Two groups: • Intervention (*n* = 124) • Control (*n* = 124)	1. Biweekly automated assessment and self-care education telephone calls 2. Nurse educator followup	Intervention group monitored glucose, feet, and weight more frequently and had fewer problems with medication adherence (*P* < 0.03). HbA_{1c} lower in intervention group (*P* = 0.01).
Raynor 1993[120]	Medication compliance	RCT	1. RCT 2. Errors over time (level 2)	1. Inpatient adults taking 2–6 medications 2. Four groups: • Nurse standard counseling • Nurse counseling and reminder chart • Pharmacist counseling • Pharmacist counseling and reminder chart	1. Counseling 2. Reminder chart or medication schedule	Groups that received reminder chart had higher medication compliance and medication knowledge than those that received counseling only (*P* < 0.01).
Rich 1996[127]	Medication adherence	RCT	1. RCT 2. Errors over time (level 2)	1. CHF patients at hospital discharge, age 70 or older 2. Two groups: • Intervention (*n* = 80) • Control (*n* = 80)	Comprehensive patient education, dietary and social service consultations, med review, and intensive postdischarge followup.	Intervention group medication adherence at 30 days posthospitalization higher than control group (*P* = 0.003).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Robbins 2004[141]	Medication adherence	Non- RCT	1. Non-RCT (Level 3) 2. Errors over time (Level 2)	Females age 65 and older with osteoporosis taking low-dose estrogen (*n* = 109)	Educational program • Monthly phone calls for 12 months. • Quarterly clinic visits. • Pill box for 6 months. • Minority women (*n* = 44) used an electronic monitoring bottle for an additional 6 months.	Adherence improved with the electronic monitoring bottle at 12 months ($P < 0.05$) in the minority women.
Rudd 2004[140]	Medication compliance	RCT	1. RCT (Level 2) 2. Clinical outcomes (Level 1)	1. Adults treated for hypertension in an outpatient clinic 2. Mean age = 60 3. Two groups: • Treatment (*n* = 74) • Control (*n* = 74)	1. Nursing case management with patient instruction on use of blood pressure equipment and self-monitoring. 2. Followup nurse calls at 1 week, 2 and 4 months. 3. Hypertension management program with standardized algorithms to modulate drug therapy based on subject's reported home blood pressure.	Intervention group had lower BP and higher adherence ($P < 0.05$).
Smith 1997[136]	Medication compliance	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Adults age 65 and older at discharge from the hospital 2. Two groups: • Treatment (*n* = 28) • Control (*n* = 25)	1. Pharmacist inpatient discharge education related to pharmaceutical plan of care 2. Telephone help line	Intervention group compliance higher 10 days postdischarge ($P < 0.01$).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Solomon 1998[226]	Medication compliance	RCT	1. RCT (Level 2) 2. Clinical outcomes (Level 1)	1. Outpatient clinic patients with hypertension or COPD 2. Mean age 66 3. Treatment HTN (*n* = 63), COPD (n = 43) 4. Control HTN (*n* = 70), COPD (*n* = 55)	Standardized pharmaceutical care, including assessment and regularly scheduled therapeutic and educational interventions.	HTN intervention group had greater SBP decrease, higher compliance, and fewer hospitalizations than HTN control ($P < 0.05$). COPD treatment group had lower use of other providers at 4 weeks (when compared to the COPD control group).
Stewart 2003[137]	Medication adherence	RCT	1. RCT (Level 2) 2. Clinical outcomes (Level 1)	1. Patients attending hypertension clinic, mean age = 57 2. Two groups: • Treatment (*n* =41) • Control (*n* =42)	1. Both groups participated in an educational program related to management of hypertension and cardiovascular risk modification. 2. Treatment group received six telephone calls to patient and six to family member over 34 weeks.	Group receiving telephone calls had greater weight loss ($P = 0.007$), knowledge related to hypertension ($P = 0.008$), adherence to medication regimen ($P = 0.05$).
Sturgess 2003[217]	Medication compliance	Group RCT	1. Group RCT (Level 2) 2. Errors over time (Level 2)	1. Community-dwelling older adults age 65 and older taking four or more medications and were regular visitors to participating pharmacies 2. Ten pharmacies randomized so that five were interventional and five were control. 3. Total of 191 subjects recruited: • Intervention (*n* =110) • Control (*n* = 81)	Intervention pharmacies received intensive training related to • Disease management education • Rationalized medications • Compliance strategies • Monitoring for 18 months	Compliance greater ($P < 0.05$) and fewer problems with medications ($P < 0.05$) in intervention group when compared to control. No difference between groups in health care costs, utilization, and quality of life was identified.

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Taylor 2003[122]	Medication review	RCT	1. RCT (Level 2) 2. Clinical outcomes (Level 1)	1. Outpatient clinic patients with three or more of the following high-risk factors: • 5 or more medications • 12 or more doses per day • 4 or more medication changes in past year • 3 or more concurrent diseases • history of medication noncompliance 2. Two groups: • Treatment (*n* = 33) • Control (*n* = 36)	1. Pharmacist intervention that included • Medical record review • Medication history review • Pharmaceo-therapeutic evaluation • Patient education • Monitoring 2. Length of treatment 1 year	Ratings for inappropriate prescribing improved in the intervention group while decreasing in the control group. In the intervention group, knowledge scores were higher (*P* = 0.000), number of prescribed medications decreased (*P* = 0.002), patient satisfaction was higher (*P* = 0.000), number of hospitalizations (*P* = 0.003) and ED visits (*P* = 0.044) were both lower when compared to the control group.
Varma 1999[124]	Medication compliance	RCT	1. RCT (Level 2) 2. Clinical outcome (Level1)	1. Persons age 65 and older with CHF who were hospitalized or attended outpatient clinic 2. Two groups: • Intervention (*n* = 42) • Control (*n* = 41)	1. Pharmacist-led medication education 2. Medication review with dose simplification	Treatment group had higher knowledge of medications (*P* = 0.0026) and fewer hospital admissions (*P* = 0.006). No difference identified in quality of life between groups.
Ware 1991[148]	Medication compliance and medication packaging	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Setting both inpatient at a geriatric assessment and rehabilitation unit and postdischarge 2. Two groups: • Treatment (*n* = 4) • Control (*n* = 39)	1. Webster-Pak medication packaging unit-dose system 2. Hospital practice prior to discharge in both groups	Compliance was higher in subjects who used unit-dose packaging system (*P* < 0.05).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Weinberger 2002[130]	Medication Compliance	Group RCT	1. Group RCT (Level 2) 2. Clinical outcomes (Level 1)	1. Pharmacy customers who had COPD or asthma as an active problem and received 70% or more of medications from a single drug store 2. Three groups: • Intervention (*n* = 447) • Control group with peak expiratory flow rates (PEFR) monitoring (*n* = 363) • Usual care control (*n* = 303)	Tailored education by pharmacist based on patient-specific data provided to the participating pharmacists.	Treatment group had higher PEFRs compared to control groups (*P* = 0.02), more satisfaction with their pharmacist (*P* = 0.001), and more satisfied with their health care at 6 months (*P* = 0.01) when compared to the control groups. The asthma patients in the pharmaceutical care group had more breathing-related ED and hospital visits than the usual care group (odds ratio, 2.16 [CI 95% 1.76–2.63; *P* < 0.001]); however, the mean age for this group was 45, younger than the COPD group whose mean age was 62.
Wilson 2001[151]	Medication compliance	RCT	1. RCT (Level 2) 2. Indirect connection to outcome (Level 3)	1. Community-dwelling outpatients over age 70 with type 2 diabetes 2. Two groups of 15 each	1. Use of Glynase Prestabs for easier tablet breaking. 2. Use of push-and-snap method to break tablets.	Higher percentage of successful tablet breaking and less pain for Glynase Prestabs than generic tablets.
Winland-Brown 2000[172]	Medication adherence	RCT	1. RCT (Level 2) 2. Errors over time (Level 2)	1. Residents of older adult independent living facility, continued monitoring 2. Three groups: • Pre-filled pill box (*n* = 16) • Voice activated (*n* = 24) • Control (*n* = 21)	Medication management methods • Pill box • Medication dispenser with voice-activated reminders	Numbers of missed doses were fewer in voice-activated group (*P* < 0.01) compared to control and compared to prefilled pill box (*P* < 0.01).

Source	Safety Issue Related to Clinical Practice	Design Type (level)	Study Design, Study Outcome Measure(s) (level)	Study Setting and Study Population	Study Intervention	Key Finding(s)
Wong 1987[149]	Medication adherence	Prospective cohort study	1. Cohort study with controls (Level 4) 2. Errors over time (Level 3)	1. Geriatric outpatient setting 2. Two groups of 11 each with crossover after 3 months	Blister-packed medications for 3 months and standard pill bottles for 3 months	Compliance was higher when subjects took medication via blister packaging ($P = 0.01$).