

# Improving primary care in rural Alabama with a pharmacy initiative

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An estimated 3–28% of all medical hospitalizations are due to preventable adverse drug events (ADEs), defined as medication-related injuries.<sup>1,2</sup> Drug-related morbidity and mortality are estimated to cost more than \$136 billion annually.<sup>1</sup> Average medical costs may be increased by \$2000 per ADE, and average hospitalizations may be lengthened by approximately two days.<sup>1,3</sup> In addition, patients may have unexpected or excessive drug responses requiring discontinuation or modification of the regimen or possibly hospitalization. These incidents, which are referred to as adverse drug reactions (ADRs), can result in temporary harm, disability, or death.<sup>2</sup>

Errors in the prescribing and management of drug therapy are responsible for many ADEs.<sup>4</sup> Inappropriate prescribing is prevalent among elderly patients and is associated with undesirable outcomes. Previous studies suggested that up to 51% of medications for elderly patients might be overused and that up to 90% might be misused.<sup>5,6</sup> Lack of knowledge and lack of timely access to patient information are considered root causes of prescribing er-

**Abstract:** The effect of pharmaceutical care on the prevention, detection, and resolution of medication-related problems in high-risk patients in a rural community was studied.

Adult patients who received care at clinics in a medically underserved area of Alabama and who were identified as being at high risk of medication-related adverse events were randomly assigned to a control group or an intervention group. The control group received standard medical care, and the intervention group received pharmaceutical care, including a medical record review, a medication history review, pharmacotherapeutic evaluation, and patient medication education and monitoring over a one-year period.

A total of 69 patients completed the study (33 in the intervention group and 36 in the control group). The percentage of patients responding to hypertension, diabetes, dyslipidemia, and anticoagulation therapy increased significantly in the intervention group and declined in the control group. Ratings for inappropriate prescrib-

ing improved in all 10 domains evaluated in the intervention group but worsened in 5 domains in the control group. There were no significant differences between the groups at 12 months in health-related quality of life or medication misadventures. Medication compliance scores improved in the intervention group but not in the control group. Medication knowledge increased in the intervention group and decreased in the control group.

Pharmaceutical care in a rural, community-based setting appeared to reduce inappropriate prescribing, enhance disease management, and improve medication compliance and knowledge without adversely affecting health-related quality of life.

**Index terms:** Anticoagulants; Compliance; Diabetes mellitus; Drugs, adverse reactions; Hyperlipidemia; Hypertension; Interventions; Patients; Pharmaceutical care; Pharmaceutical services; Prescribing; Quality of life; Rational therapy

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rors.<sup>4</sup> Medication errors, ADEs, and ADRs are collectively defined as medication misadventures, in which an iatrogenic incident occurs that may be attributable to “error, immunologic response, or idiosyncratic re-

sponse and is always unexpected or undesirable to the patient.”<sup>2</sup>

Most research describing ADEs, ADRs, and medication errors has been conducted in hospital environments, not outpatient settings.<sup>7</sup>

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Therefore, factors associated with outpatient ADEs are unclear. Additional information is particularly needed regarding medication misadventures in rural outpatient environments. Clinical and educational pharmacy services in the ambulatory care setting have been shown to improve drug therapy documentation, prescribing, medication compliance, and overall health outcomes.<sup>6</sup> These services are especially needed in rural areas, where access to medical and pharmaceutical services is often limited.

This article describes the implementation and outcomes of a rural education and drug information program in a medically indigent population. This was a collaborative, community-based, civic-engagement program that extended pharmaceutical care services into rural areas of Alabama. The program's primary purpose was to determine the effect of pharmaceutical care on the prevention, detection, and resolution of drug-related problems in high-risk patients in a rural community.

## Methods

**Study design and program implementation.** The local institutional review board approved a randomized controlled study designed to monitor patients for one year in community-based physician offices in order to document the influence of pharmaceutical care services. Practice sites included three community-based family medicine clinics affiliated with the University of Alabama School of Medicine—Tuscaloosa and located in the neighboring towns of Aliceville and Gordo in Pickens County, Alabama.

Pickens County is 1 of 12 counties referred to alternatively as Alabama's Third World (after the region's severe poverty) or the Black Belt (after the rich, dark soil that supported extensive cotton production in the 1800s).<sup>8</sup> This county ranks among the poorest 13% of counties in the

United States and is characterized by a low life expectancy, a low ratio of physicians to residents, inadequate prenatal care, and high rates of sexually transmitted diseases, asthma, diabetes, dyslipidemia, and cardiovascular diseases. Residents routinely do not seek preventive care because they lack transportation and insurance coverage.

The study was begun in December 1998 by conducting orientation sessions at each clinic to familiarize physicians and clinic staff with the protocol. Study kits consisting of data collection forms, patient informed consent forms, and pertinent surveys were distributed. Space was established at each site for various pharmacist functions, including patient interviews and counseling. Mechanisms were established for identifying patients meeting inclusion criteria and for patient follow-up. Investigator-training sessions were conducted with all involved pharmacists to review the protocol and tools for documenting patient demographics, medication knowledge, compliance, prescribing appropriateness, and satisfaction. Patient education packets were developed by the pharmacists conducting the study for hypertension, diabetes mellitus, dyslipidemia, and anticoagulation services.

A system was developed in which the patient, physician, or nurse reported suspected problems with drug therapy. Patients, nurses, and physicians were educated about the signs and symptoms of medication misadventures. These reports were prepared on index cards and individually reviewed by a pharmacist. In addition, pharmacists noted any drug-related problems detected during inspection of prescription bottles or during patient interviews.

**Patient selection.** Adult patients (18 years or older) who received care at the participating clinics and were identified as being at high risk for medication-related adverse events were enrolled after giving informed

consent. Patient enrollment began in January 1999. High risk was defined as presence of three or more of the following risk factors: five or more medications in the drug regimen, 12 or more doses per day, four or more medication changes in the previous year, three or more concurrent diseases, a history of medication non-compliance, and the presence of drugs requiring therapeutic monitoring. We considered a patient to be noncompliant if the physician made that assessment in the medical record or if the patient demonstrated a pattern of noncompliance in self-reports or the medication-refill history. Drugs that were considered to necessitate monitoring were long-term medications requiring laboratory testing to ensure safety and efficacy, such as warfarin, theophylline, and phenytoin. Patients were excluded from the study if they had significant cognitive impairment, a history of missed office visits, scheduling conflicts, or a life expectancy of less than one year.<sup>9</sup>

Patients were identified by the participating pharmacists through manual evaluation of clinic medical records and review of computerized medical records in physician offices.

**Randomization and intervention.** In the study, four pharmacists joined to provide pharmaceutical care at the clinics two or three afternoons per week. Since the clinics did not have a pharmacy, interventions were limited to clinical services and patient education and did not include dispensing. However, patients were asked to bring all their current medications on follow-up visits, and the pharmacists contacted local pharmacies for dispensing information as necessary.

Patients were randomly assigned to a control group or an intervention group. The control group received standard medical care, and the intervention group received standard medical care plus pharmaceutical care (Table 1).

Table 1.  
Summary of Pharmacist Interventions

Pharmacist Activity	Intervention Group	Control Group
<i>Baseline</i>		
Reviewing medical records	Yes	Yes
Obtaining patient consent	Yes	Yes
Conducting comprehensive interview <sup>a</sup>	Yes	Yes
Evaluating pharmacotherapy	Yes	Yes
<i>Follow-up</i>		
Evaluating pharmacotherapy	Yes	Yes
Making therapeutic recommendations	Yes	No
Obtaining medication history and documentation	Yes	No
Providing patient-specific drug education and monitoring	Yes	No
Applying compliance-enhancing strategies	Yes	No
Assessing compliance	Yes	Yes
Evaluating medication misadventures	Yes	Yes
Evaluating medication knowledge	Yes (V3 <sup>b</sup> )	Yes (V3)
Applying Medication Appropriateness Index	Yes (V2, <sup>c</sup> V3)	Yes (V2, V3)
Administering SF-36 and patient satisfaction survey	Yes (V3)	Yes (V3)

<sup>a</sup>Including obtaining demographic data, administering 36-Item Short Form (SF-36), and evaluating medication compliance and knowledge.

<sup>b</sup>V3 = third clinic visit (one year after baseline).

<sup>c</sup>V2 = second clinic visit (six months after baseline).

**Control group.** Medical record review and patient interviews at baseline and one year later were performed by a pharmacist for comparison. Information collected included compliance, presence of medication misadventures, and medication knowledge. Also, the patients were asked to complete a survey at the end of the study. A pharmacist evaluated each control patient's pharmacotherapy and documented clinical outcomes, but provided no advice or recommendations to the patient or physician. Data were collected primarily from medical records to minimize contact with control patients.

**Intervention group.** Patients in the intervention group received usual medical care, along with pharmacotherapeutic interventions by a pharmacist during regularly scheduled office visits. A patient typically met with a pharmacist for 20 minutes before seeing a physician. The intervention was based on the principles of pharmaceutical care, a uniform process for preventing or identifying and resolving problems related to

drug therapy.<sup>10</sup> Published therapeutic algorithms and guidelines were used as the basis of the pharmacists' recommendations. The pharmacists were specifically trained to evaluate a therapy's indication, effectiveness, and dosage, as well as the correctness and practicality of directions, drug-drug interactions, drug-disease interactions, therapeutic duplication, the duration of treatment, untreated indications, and expense. The pharmacists reviewed the medical record for medication-related problems, conducted a chart review to ensure that information on drug therapy and allergies was accurately documented, examined the medication history to determine compliance with and complications of medications, and provided comprehensive individualized patient education that included a brief review of the disease, important lifestyle modifications, and basic drug information.<sup>11</sup>

Therapeutic recommendations were communicated to physicians through discussions or progress notes. The pharmacists also provided

drug and disease information during follow-up visits and answered patients' questions. Written materials were provided. In addition, the pharmacists monitored patients' responses to drugs and attempted to improve compliance by consolidating medication regimens, reducing dosage frequency, devising medication reminders, and teaching patients techniques for using such devices as inhalers, peak flow meters, glucometers, and pill boxes.

#### Endpoints and statistical analysis.

We identified specific clinical endpoints for review at baseline and throughout the study, including hypertension (blood pressure), diabetes (hemoglobin A<sub>1c</sub> concentration), anticoagulation (International Normalized Ratio [INR]), and dyslipidemia (low-density-lipoprotein [LDL] cholesterol concentration). Baseline values were reported as the average of the two most recent readings. These endpoints were chosen because of the high prevalence of hypertension, diabetes, dyslipidemia, and cardiovascular disease in the study population. The number of patients who were at goal levels at baseline and at the end of the study were compared by using chi-square analysis. To examine the effect of the interventions on prescribing, repeated-measures analysis of variance (ANOVA) was used. Percentages were used to describe medications deemed inappropriate on the basis of each of the 10 domains of the Medication Appropriateness Index (MAI).<sup>12</sup>

A patient-satisfaction survey completed at the end of the study was evaluated with repeated-measures ANOVA. Patient self-reports were used to assess medication compliance. A noncompliant patient was defined as an individual with a compliance score of <80%, calculated by asking the patient the number of medication doses missed during the past week or month and dividing the estimated number of doses taken by the total number of doses pre-

scribed. For example, if a patient stated that he or she missed five doses of a once-daily medication during the past month, the compliance score would be 83% (25/30). Compliance scores for each medication were combined to calculate the mean compliance score. The percentage of noncompliant patients was compared between groups by using chi-square analysis. The change in the compliance rate from baseline was evaluated with repeated-measures ANOVA. Noncompliant patients completed a brief questionnaire to explore possible reasons for the problem.

Patient self-reports were used to assess medication knowledge during each pharmacist-patient encounter. A knowledge score was determined by dividing the number of medications for which a patient reported the correct name, purpose, dose, and frequency by the total number of medications and multiplying by 100. The results were compared between groups with Student's *t* test or the rank sum test. The percent change in medication knowledge scores was evaluated with repeated-measures ANOVA.

The Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) assesses the quality of life in terms of physical health (physical functioning, physical role function, pain, and general health) and mental health (mental health, emotional role function, social functioning, and energy).<sup>13</sup> Changes in the eight health-related quality-of-life domains were assessed at study enrollment and the end of the study by using repeated-measures multivariate ANOVA.

Medication misadventures were identified for all enrolled patients. The number of patients who had at least one medication misadventure was divided by the total number of patients in each group to yield a percentage. The percentage of misadventures in the control group was compared with that in the interven-

tion group by using chi-square analysis. Since multiple pairwise comparisons were conducted during this study, a Bonferroni correction was conducted, and the a priori  $\alpha$  level was set at 0.003.

The baseline characteristics of the study groups were assessed with Student's *t* test and the chi-square test or Fisher's exact test. A medical record review was conducted at baseline to determine the number of emergency department (ED) visits and hospitalizations for each patient that occurred during the preceding year. Data for the same variables were collected during the study period. Frequency changes were compared by using the paired *t* test.

### Results

At baseline, the intervention and control groups were not significantly different with respect to demographic characteristics and medication use, compliance, and knowledge (Table 2). The patients' four most common diseases were hypertension (51%), dyslipidemia (40%), diabetes mellitus (27%), and osteoarthritis (12%). Over 17% of the patients had no insurance coverage for prescription medications.

End-of-study interviews were completed for 69 (85%) of the 81 patients who were initially enrolled (33

intervention-group patients and 36 controls). Twelve patients were not included because they were lost to follow-up (3 intervention-group patients and 3 controls), they died (2 and 1), or they refused to participate (3 and 0).

**Clinical outcomes.** *Hospitalizations and ED visits.* The number of hospitalizations and ED visits decreased in the intervention group while remaining constant in the control group compared with the year preceding enrollment. Eleven hospitalizations were reported for the control group in the year prior to the study, compared with 24 in the intervention group. During the study year, the control group had 11 hospitalizations, and the intervention group had 2 ( $p = 0.003$ ). The number of ED visits remained constant in the control group at 6 and decreased in the intervention group from 18 in the year before the study to 4 during the study ( $p = 0.044$ ).

*Hypertension.* At baseline, there was no significant difference in systolic or diastolic blood pressure of patients with diagnosed hypertension in either group. (Table 3) Mean blood pressures at baseline were above the recommended goals for hypertension treatment. However, the percentage of patients at the targeted blood pressure was higher at baseline

Table 2.  
**Comparison of Study Groups at Baseline**

Characteristic or Variable	Intervention Group (n = 33)	Control Group (n = 36)	p
Sex (% male)	36.4	27.8	0.445
Race (% white)	60.6	61.1	0.966
Mean $\pm$ S.D. age (yr)	64.4 $\pm$ 13.7	66.7 $\pm$ 12.3	0.467
Marital status (% married)	75.8	72.2	0.935
Median education, yr (range)	12 (4–16)	12 (8–16)	0.980
Mean $\pm$ S.D. no. medications	6.3 $\pm$ 2.2	5.7 $\pm$ 1.7	0.201
Mean $\pm$ S.D. % compliance <sup>a</sup>	84.9 $\pm$ 6.7	88.9 $\pm$ 5.8	0.728
Mean $\pm$ S.D. medication knowledge score (%)	56.3 $\pm$ 9.7	58.2 $\pm$ 10.4	0.709

<sup>a</sup>Percentage of patients with compliance scores of 80–100%.

in the control group (31.0%) than in the intervention group, although the difference was not significant. At 12 months, intervention-group patients were significantly more likely than control patients to have targeted blood pressures. Furthermore, there was a significant increase from baseline in the percentage of patients at goal in the intervention group.

**Diabetes mellitus.** At baseline, the diabetic patient in the two groups had similar hemoglobin A<sub>1c</sub> values (Table 3). The percentage of patients achieving the therapeutic goal increased from 23.1% to 100.0% in the intervention group during the 12-month period but decreased in the control group. The percentage of patients meeting the goal at 12 months was significantly higher in the intervention group than in the control group.

**Dyslipidemia.** Baseline LDL cholesterol values did not differ significantly between the groups, and cholesterol in both groups appeared to be poorly controlled (Table 3). The intervention group had a dramatic improvement in LDL cholesterol at 12 months, while the percentage of patients in the control group meeting LDL cholesterol goals actually declined.

**Anticoagulation.** Less than half of patients in both groups had therapeutic INRs at baseline (Table 3). At 12 months, all patients in the intervention group had INRs within the targeted range, but only 25% of control patients did.

**Quality of life.** No significant differences in health-related quality-of-life scores were observed between the groups at baseline or at 12 months (Table 4). The intervention group's score improved in each category, but not significantly.

**Prescribing appropriateness and medication misadventures.** Table 5 shows the percentage of prescriptions that were considered inappropriate on the MAI. The percentage of inappropriate prescriptions decreased

in all 10 MAI domains in the intervention group and increased in 5 domains in the control group. The domains in which prescribing was most frequently inappropriate were dosage, correctness of directions, practicality of directions, and expense.

Of the seven patients reporting medication misadventures, four were in the intervention group and three were in the control group (Table 6). A variety of minor ADRs were reported, including anxiety, confusion, cough, wheezing, swelling, and rash.

Table 3. Clinical Outcomes

Item	Intervention Group	Control Group	p
Hypertension			
No. pts.	24	29	...
No. (%) pts. at goal <sup>a</sup>			
Baseline	3 (12.5)	9 (31.0)	0.109
12 mo	22 (91.7)	8 (27.6)	0.001
Diabetes mellitus			
No. pts.	13	16	...
No. (%) pts. at goal <sup>b</sup>			
Baseline	3 (23.1)	9 (56.3)	0.071
12 mo	13 (100.0)	5 (26.7)	0.001
Dyslipidemia			
No. pts.	19	19	...
No. (%) pts. at goal <sup>c</sup>			
Baseline	2 (10.5)	3 (15.8)	0.631
12 mo	14 (77.8)	1 (5.9)	0.001
Anticoagulation			
No. pts.	4	6	...
No. (%) pts. at goal <sup>d</sup>			
Baseline	1 (25.0)	3 (50.0)	0.571
12 mo	4 (100.0)	1 (16.7)	0.048

<sup>a</sup>The goal for hypertension treatment was a systolic blood pressure of ≤140 mm Hg and a diastolic blood pressure of ≤90 mm Hg, except for patients with diabetes mellitus, in whom the goal was a systolic blood pressure of ≤135 mm Hg and a diastolic blood pressure of ≤80 mm Hg.

<sup>b</sup>The goal for diabetes mellitus treatment was a hemoglobin A<sub>1c</sub> concentration of ≤7.5%.

<sup>c</sup>The goal for dyslipidemia treatment was based on the practice guidelines of Adult Cholesterol Education Program Adult Treatment Panel III.

<sup>d</sup>The goal for anticoagulation therapy was an International Normalized Ratio of 2–3.

Table 4. Health-Related Quality-of-Life Scores<sup>a</sup>

Domain	Mean ± S.D. Score <sup>b</sup>			
	Intervention Group (n = 33)		Control Group (n = 36)	
	Baseline	12 Months	Baseline	12 Months
Physical functioning	62.0 ± 29.4	68.6 ± 24.0	61.9 ± 24.3	56.1 ± 27.5
Social functioning	70.6 ± 24.9	77.8 ± 24.3	73.3 ± 26.6	73.0 ± 28.2
Physical role function	50.8 ± 42.2	68.2 ± 42.1	47.9 ± 42.8	52.8 ± 42.2
Emotional role function	59.6 ± 44.7	82.8 ± 36.4	69.4 ± 45.3	65.8 ± 45.4
Mental health	72.0 ± 17.4	73.1 ± 21.2	69.0 ± 18.6	72.3 ± 17.1
Energy	47.0 ± 23.5	55.6 ± 20.3	46.9 ± 24.1	47.9 ± 20.2
Pain	60.0 ± 27.0	68.5 ± 22.3	65.4 ± 23.0	63.1 ± 25.8
General health perception	50.8 ± 19.5	57.0 ± 19.6	49.9 ± 19.8	50.1 ± 15.9

<sup>a</sup>On Medical Outcomes Study 36-Item Short Form.

<sup>b</sup>None of the differences between groups were significant.

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No severe medication misadventures were reported.

The percentage of patients with medication compliance scores of 80–100% increased by 15% in the intervention group. Compliance in the control group did not change from baseline. However, compliance scores did not differ significantly between the groups at baseline or at 12 months. The most frequently cited reasons for noncompliance were forgetting to take medications ( $n = 10$ ), medication costs ( $n = 10$ ), having too many medications to take ( $n = 9$ ), difficulty reading or understanding medication directions ( $n = 4$ ), and considering taking medications too much trouble ( $n = 4$ ).

Mean medication knowledge scores in the intervention group were 36% higher at 12 months. In contrast, the control group had a medication knowledge score reduction of 15% ( $p < 0.0001$ ).

### Discussion

The patients in this study were primarily elderly white women and had 4–16 years of education. They were taking an average of six medications each and had considerably less medication knowledge and higher noncompliance at baseline than patients in a study by Hanlon et al.<sup>6</sup> of the impact of pharmacist interventions on prescribing in the elderly.

Our study found that pharmaceutical care services in a rural community reduced inappropriate prescribing, enhanced disease management, and improved medication compliance and knowledge without adversely affecting health-related quality of life. The findings confirm that pharmaceutical care is of value in the rural clinic setting, just as it is in other ambulatory care settings.<sup>14</sup>

Hospitalizations and ED visits fell by 92% and 78%, respectively, in the intervention group but remained unchanged in the control group. This result should be interpreted cautiously, since the investigators did

Table 5.  
Inappropriate Prescribing

Domain of MAI <sup>a</sup>	No. (%) of Prescriptions That Were Inappropriate			
	Intervention Group		Control Group	
	Baseline ( $n = 210$ Prescriptions)	12 Months ( $n = 155$ Prescriptions)	Baseline ( $n = 207$ Prescriptions)	12 Months ( $n = 224$ Prescriptions)
Indication	70 (33.3)	25 (16.1)	97 (46.8)	108 (48.2)
Effectiveness	61 (29.1)	21 (13.6)	93 (44.9)	100 (44.6)
Dosage	133 (63.3)	20 (12.9)	129 (62.3)	143 (63.8)
Correctness of directions	148 (70.5)	34 (21.9)	133 (64.3)	143 (63.8)
Practicality of directions	128 (61.0)	46 (29.7)	118 (57.0)	127 (56.7)
Drug–drug interaction	48 (22.9)	9 (5.8)	37 (17.9)	51 (22.8)
Drug–disease interaction	39 (18.6)	14 (9.0)	44 (21.3)	44 (19.6)
Therapeutic duplication	25 (11.9)	7 (4.5)	14 (6.8)	17 (7.6)
Duration of therapy	74 (35.2)	28 (18.1)	101 (48.8)	110 (49.1)
Expense	105 (50.0)	60 (38.7)	129 (62.3)	135 (60.3)

<sup>a</sup>MAI = Medication Appropriateness Index.

Table 6.  
Other Outcome Measures at 12 Months

Outcome Measure	Intervention Group ( $n = 33$ )	Control Group ( $n = 36$ )	$p$
Patients with at least one medication misadventure (%)	2.8	3.0	0.731
Mean $\pm$ S.D. patients who were compliant (% <sup>a</sup> )	100	88.9 $\pm$ 6.3	0.115
Mean $\pm$ S.D. medication knowledge score (%)	92.6 $\pm$ 3.4	42.9 $\pm$ 12.8	0.000
Mean $\pm$ S.D. no. prescribed medications	4.7 $\pm$ 2.0	6.2 $\pm$ 2.0	0.002
Mean $\pm$ S.D. no. pts. with pharmacy-related satisfaction	81.9 $\pm$ 4.8	89.0 $\pm$ 6.2	0.000
Change in no. hospitalizations <sup>b</sup>	-22	0	0.003
Change in no. ED visits <sup>b</sup>	-12	0	0.044

<sup>a</sup>Percentage of patients with compliance scores of 80–100%.

<sup>b</sup>Change in the number of hospitalizations or emergency department (ED) visits over the period from 12 months before baseline to 12 months after baseline.

not identify whether hospitalizations and ED visits were due to a complication or to poor control of disease. The outcomes of hypertension, diabetes, dyslipidemia, and anticoagulation therapy appeared to be substantially improved by the pharmacists' management. The pharmacists provided recommendations regarding all medication-related problems identified; however, patient-specific outcomes were reported only for these four common clinical situations because of an a priori decision. The study could not fully control for

possible confounders. For example, blood pressure readings were not taken by the same person with the same sphygmomanometer throughout the study. In addition, it was not documented whether abnormal values for blood pressure, glucose, lipids, or INR corresponded to a confounding circumstance, such as an infection.

After one year, the percentage of intervention-group patients for whom prescribing was inappropriate declined approximately 60%; such prescribing remained almost unchanged in the control group. The

study by Hanlon et al.<sup>6</sup> found a 24% reduction in inappropriate prescribing at 12 months among patients at a Veterans Affairs medical center who received pharmacist interventions, compared with only a 6% decline among control patients ( $p = 0.0006$ ). No between-group differences in quality of life, compliance, or satisfaction were noted by these authors. Differences in appropriateness scores could have been due to the uniqueness of the environment in which the MAI was applied. The pharmacists in our study were trained to use the index, and an independent reviewer evaluated the accuracy and consistency of the determinations among pharmacists.

Medication misadventures did not differ significantly in frequency between the intervention group and the control group. Also, patient knowledge about medications improved in the intervention group, but not among the controls. O'Connell and Johnson<sup>15</sup> have noted that many factors may contribute to changes in patients' medication knowledge and compliance, including lack of individualized counseling, lack of written instructions to reinforce oral instructions, inability to recall information, and lack of compliance aids.

The mean number of prescribed medications declined significantly in the intervention group compared with the control group. It is possible that this reduction contributed to the increased compliance of the intervention group.

This study has several limitations. The small sample and short follow-up period limited the ability to detect

significant differences in some of the patient-specific outcomes and may limit the generalizability of the results. Although patients were randomized, physicians were not because of the small number of physicians practicing in the rural community. We did not evaluate differences between clinic sites or physicians. The clinical importance of the differences in MAI scores and SF-36 results is unclear. The MAI is restricted to 10 elements of prescribing and does not adequately identify underprescribing. While the MAI represents an intermediate outcome, and the SF-36 may not adequately measure changes in quality of life influenced by pharmaceutical care, it can be concluded that pharmacist interventions do improve patient care. Finally, we did not document the percentage of pharmacist recommendations that were implemented to evaluate whether a difference existed between physicians and pharmacists with respect to recommendation acceptance. It could have been possible for such differences to inadvertently reflect differences between the two groups.

**Conclusion**

Pharmaceutical care in a rural, community-based setting appeared to reduce inappropriate prescribing, enhance disease management, and improve medication compliance and knowledge without adversely affecting health-related quality of life.

**References**

1. Classen DC, Pestotnik SL, Evans S et al. Adverse drug events in hospitalized patients: excess length of stay, extra costs, and attributable mortality. *JAMA*. 1997; 277:301-6.
2. American Society of Health-System

Pharmacists. Suggested definitions and relationships among medication misadventures, medication errors, adverse drug events, and adverse drug reactions. *Am J Health-Syst Pharm*. 1998; 55:165-6.

3. Bates DW, Spell N, Cullen DJ et al. The costs of adverse drug events in hospitalized patients. *JAMA*. 1997; 277:307-11.
4. Lesar TS, Briceland L, Stein DS. Factors related to errors in medication prescribing. *JAMA*. 1997; 277:312-7.
5. Brook RH, Kamberg CJ, Mayer-Oakes A et al. Appropriateness of acute medical care for the elderly: an analysis of the literature. *Health Policy*. 1990; 14:225-42.
6. Hanlon JT, Weinberger M, Samsa GP et al. A randomized, controlled trial of a clinical pharmacist intervention to improve inappropriate prescribing in elderly outpatients with polypharmacy. *Am J Med*. 1996; 100:428-37.
7. Finn B, Carlstedt BC. Reporting adverse drug reactions in an ambulatory care setting. *Am J Health-Syst Pharm*. 1995; 52:2704-6.
8. Hansen J, Archibald J. Life is short, prosperity is long gone. <http://al.com/specialreport/birminghamnews/?blackbelt1.html> (accessed 2003 Jan 3).
9. Koecheler JA, Abramowitz PW, Swim SE et al. Indicators for the selection of ambulatory patients who warrant pharmacist monitoring. *Am J Hosp Pharm*. 1989; 46:729-32.
10. Robertson KE. Process for preventing or identifying and resolving problems in drug therapy. *Am J Health-Syst Pharm*. 1996; 53:639-50.
11. American Society of Health-System Pharmacists. ASHP guidelines on pharmacist-conducted patient education and counseling. *Am J Health-Syst Pharm*. 1997; 54:431-4.
12. Samsa GP, Hanlon JT, Schmader KE et al. A summated score for the medication appropriateness index: development and assessment of clinimetric properties including content validity. *J Clin Epidemiol*. 1994; 8:891-6.
13. Ware JE, Sherbourne CD. The MOS 36-Item Short-Form Health Survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992; 30:473-83.
14. Carter BL, Helling DK. Ambulatory care pharmacy services: has the agenda changed? *Ann Pharmacother*. 2000; 34:772-87.
15. O'Connell MB, Johnson JF. Evaluation of medication knowledge in elderly patients. *Ann Pharmacother*. 1992; 26:919-21.