The purpose of this study was to evaluate the impact of a self-management program for adults with moderate to severe asthma on compliance with inhaled, prescribed, nonemergency medications; asthma symptoms; and airway obstruction. In this controlled experimental study, 55 subjects from a rural community were randomized to one of two groups. Self-efficacy theory served as the framework for this study. Primary measures included the Metered Dose Inhaler (MDI) Chronolog, a journal of daily asthma concerns, and a peak-flow meter to appraise airway obstruction. Secondary measures included the Asthma Self-Management Assessment Tool (ASMAT) and the Self-Efficacy for Asthma Management Scale (SEAMS). These measures were completed pre- and post-intervention. Data analysis using descriptive and inferential statistics revealed that subjects receiving the self-management program increased compliance with inhaled medications (U = 271, p = .043).

An Evaluation of a Self-Management Program for Adults With Asthma

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Approximately 12 million Americans have asthma (National Center for Health Statistics, 1993). Asthma contributes substantially to morbidity and mortality. Indeed, according to National Health Statistics, the death rate attributable to asthma nearly doubled between 1979 and 1987 (National Center for Health

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Statistics, 1993). Strunk (1989) and other asthma specialists suggest that many of these deaths can be prevented by focusing on the behavioral factors which influence the self-management of asthma.

One component of self-management is compliance with the medical regimen. Noncompliance has been shown to increase mortality and morbidity (Spector et al., 1986). The problem of managing compliance is complicated by the finding that patients overestimate their own compliance with the recommended regimen. Several studies have compared self-report with more direct indicators of medication compliance (Glanz, Stanley, Swartz, & Francis, 1984; Spector et al., 1986). Although patients report approximately 90% compliance, direct measures such as urine testing, electronic monitoring, and pill counts show a 50% to 60% compliance rate (Dunbar, 1980). Thus, interventions aimed at improving compliance need to address the issue of patient's recognition and/or reporting of their regimen behaviors.

Self-management programs encourage the participation of the patient in the daily management of a chronic illness and are based on behavioral and social learning theory (Holroyd & Creer, 1986). Programs which implement self-management strategies have led to less pain in arthritics (Lorig & Holman, 1989), fewer asthma attacks in asthmatics (Creer, 1991) and weight loss in Type II diabetics (Wing, Epstein, Nowalk, & Lamparski, 1986). The addition of a self-efficacy enhancing component to these programs has shown benefit (Lorig & Holman, 1989). Self-efficacy has been shown to be a significant factor for many health care behaviors and is linked to general health functioning (O'Leary, 1985; O'Leary, Shoor, Lorig, & Holman, 1988). It may be postulated that perceived self-efficacy expectancies have a strong influence on chronically ill patients' ability to manage their own care.

The purpose of this study was to evaluate the impact of a nurse-administered asthma self-management program on patient compliance, asthma symptoms, and airway obstruction among patients treated in a rural setting. The majority of studies conducted have targeted urban minority populations that are more at risk for asthma complications. Few if any studies have considered the rural patient who has a longer distance to travel for care and is dependent for a longer period upon his/her own skills or those of family members during an acute attack. More

studies are needed to assess the impact of rural dwelling on those with asthma.

The major hypotheses addressed in this study were that subjects receiving a self-management program would: increase compliance with inhaled medications, decrease the frequency of asthma symptoms, increase the percentage of symptom-free days, and decrease airway obstruction. Secondary hypotheses were that subjects receiving the program would have increased self-efficacy and increased self-management behaviors.

METHOD

DESIGN

This study used a two-group randomized, controlled experimental design. Subjects were randomly assigned to one of two groups: usual care or self-management intervention. Both groups received usual and routine care offered by their physicians. In addition, the experimental group received a 6-week asthma self-management program. Subjects in both groups recorded medication taking and symptom information and used the Metered Dose Inhaler (MDI) Chronolog (an electronic measure of inhaler use) daily for 1 week before initiation of the program. Baseline measures were assessed daily for 1 week and included daily peak-flow determinations (using the peak-flow meter and recorded in an asthma diary), compliance with inhaler use (using both the MDI Chronolog and self-report with the diary), asthma symptoms (as self-reported in the diary), and questionnaires to assess asthma self-management and self-efficacy. Treatment consisted of 6 weekly education sessions and self-monitoring throughout the 6-week program. Post-treatment assessments were also made daily for 1 week and were identical to baseline measures.

SAMPLE

The population included rural dwelling adults age 18 years and older with a medical diagnosis of asthma who were being treated with prescribed, regularly administered, inhaled medications other than as-needed bronchodilators. Those who had other respiratory disorders or were current smokers were

excluded. After an initial screening for eligibility, subjects were classified according to asthma severity using a three-level severity rating scale—mild, moderate, or severe—based on the American Thoracic Criteria guidelines (National Asthma Education Program Expert Panel Report, 1991). Specific criteria to classify asthma severity included frequency of physical symptoms, work attendance, use of medications, ability to carry out exercise, and peak flow readings. Subjects were stratified on asthma severity due to the possible influence of severity on compliance behavior. A stratified random permuted block scheme was employed for generation of treatment assignments for subjects with moderate and severe asthma (Pocock, 1983; Rudy, Vaska, Daly, Happ, & Shiao, 1993).

Brochures were placed in physician offices and pharmacies, and information about the study was announced on the radio and in newspapers. Potential subjects were called after they indicated an interest in participation. Of 136 adults screened, 87 (64%) were eligible for inclusion. Sixty-eight (78%) signed consent forms were returned. Before the initiation of the program, 13 (19%) withdrew from the study due to weather problems and illness. Therefore, 55 subjects participated in the program with 24 in the control group and 31 subjects in the treatment group. Fifty-four subjects completed the program and 1 subject withdrew but was included in the analysis. No previous intervention studies using similar compliance outcome measures reported the appropriate summary statistics of their data to estimate sample size. In light of this, approximations were made according to recommendations using Cohen (1988). The significance level was set at .05 and the power level was set at .80. A moderate effect size of .5 was chosen, given the nature of the data and lack of pilot data.

The subjects were predominantly female, Caucasian, and married. Subject characteristics are presented in Table 1. The subjects in the sample were relatively well educated. There were no significant differences found between groups on these characteristics.

PROCEDURE

Self-management intervention. The self-management program was adapted from a program designed by Creer, Reynolds, and

Table 1
Descriptive Statistics for Treatment and Control Subjects

Characteristic	Overall n (%)	Treatment n (%)	Control n (%)	χ^2(df)*
Gender				
Male	19 (35)	10 (32)	9 (38)	.164(1)
Female	36 (66)	21 (68)	15 (62)	
Ethnicity				
Caucasian	52 (95)	29 (93)	23 (96)	.137(1)
Non-Caucasian	3 (5)	2 (7)	1 (4)	
Marital status				
Single	19 (35)	11 (35)	8 (33)	.027(1)
Married	36 (65)	20 (65)	16 (67)	
Insurance				
Insured	51 (91)	29 (93)	21 (87)	.599(1)
Not insured	15 (11)	2 (7)	3 (13)	
Education				
Grade school	1 (2)	1 (3)	0 (0)	5.745(3)
High school/some college	35 (64)	23 (74)	12 (50)	
Bachelor's degree	5 (9)	1 (3)	4 (17)	
Graduate school	14 (26)	6 (19)	8 (33)	
Employment				
Full-time/part-time	34 (62)	18 (58)	16 (67)	.424(1)
Unemployed	21 (38)	13 (42)	8 (33)	
Occupation				
Professional	24 (44)	12 (39)	12 (50)	.701(1)
Nonprofessional	31 (56)	19 (61)	12 (50)	
Income (in dollars per year)				
<10,000	9 (17)	6 (20)	3 (12)	2.541(4)
10,001-30,000	20 (37)	13 (43)	7 (29)	
30,001-50,000	11 (20)	5 (17)	6 (25)	
50,001-70,000	7 (13)	3 (10)	4 (17)	
>70,000	7 (13)	3 (10)	4 (17)	
Smoking				
Past	27 (49)	15 (48)	12 (50)	.014(1)
Never	28 (51)	16 (52)	12 (50)	
Health problems				
Yes	28 (51)	15 (48)	13 (54)	.180(1)
No	27 (49)	16 (52)	11 (46)	
Asthma severity				
Moderate	41 (74)	22 (71)	19 (79)	.479(1)
Severe	14 (26)	9 (29)	5 (21)	

(continued)

Table 1
Descriptive Statistics for Treatment and Control Subjects

Characteristic	Overall *n* (%)	Treatment *n* (%)	Control *n* (%)	Statistic
Age				
Mean	50	47	52	
Standard deviation	16	15	15	
t-test				$t = -1.35$
Years with asthma				
Mean	20	17	23	
Standard Deviation	17	18	17	
t-test				$t = -1.13$

NOTE: Percentages presented are column percentages.
*$p < .05$.

Kotses (1992) and consisted of 6 sessions, which included information about self-management behaviors and skills, asthma medications, asthma triggers, prevention of asthma attacks, relaxation techniques, psychological responses to asthma, and problem-solving skills. The sessions, which were held in the community, lasted approximately 2 hours and were led by registered nurses who were knowledgeable about asthma. All information that was given to subjects was scripted in a 204-page handbook for group leaders. There were five groups, running from January to May, with approximately 10 subjects in each group. New groups started at 2-week intervals.

Usual care. Subjects randomized to this condition recorded information daily for 1 week following randomization and again at follow-up for treated subjects. No other intervention was given to this group aside from usual care with physician.

INSTRUMENTS

The instruments used in this study were administered at Week 1 and at Week 7 of each protocol. In order to assure that treatment differences were not due to inability to use the MDI correctly, skills with inhaler use were assessed and reinforced at baseline.

MDI Chronolog. The MDI Chronolog (Forefront Engineering Corporation, Denver, CO) is a monitoring device which is designed

to house an MDI and was used to assess compliance. Each time a subject uses the inhaler, a microswitch is activated and the Chronolog records the date and time. Summary output data show the date and time of each subject activation for the period monitored. In this study, this was compared with the self-reported medication prescription. Compliance scores were calculated for each day and ranged from 0 to 100%. The memory unit of the MDI Chronolog stores the date and time of each triggered activation within approximately 4 seconds. A total of 4,000 events can be stored. Data obtained from the chronolog were downloaded into a computer for storage and analysis. Reliability for the chronolog has been reported in the literature (r = .95 – .98) (Rand et al., 1992; Spector et al., 1986) and was tested before initiation of this study (r = .95).

Journal of daily asthma concerns. A journal of daily asthma concerns was completed by each subject as part of the self-management program and was also used as an additional measure of compliance for all subjects. This type of diary has been used in self-management programs and other traditional asthma protocols (Creer et al., 1992). Subjects were asked to complete information about medication-taking behavior on a daily basis. For the assessment of asthma symptoms, subjects were required to record information about the presence or absence of four different symptoms: wheeze, cough, shortness of breath, and chest tightness. Subjects also recorded information about the frequency of asthma attacks during daytime and nighttime, and peak-flow readings. Information obtained from the diary on attack frequency was part of a secondary analysis and was not the aim of this study.

Spirometrics peak-flow meter. Subjects were given a peak-flow meter (Spirometric, Inc., Auburn, ME), taught to use it, and asked to record peak-flow measurements twice a day. The peak-flow device is able to measure peak-flow readings of 90-700 lpm for adults. Subjects were instructed to perform three peak-flow measures both in the morning and in the evening and document the highest readings in the asthma diary. Reliability and validity of this tool have been reported (Burns, 1979; Wright & McKerrow, 1959). According to the manufacturer's brochure, the peak-flow meter is accurate and repro-

ducible to ± 5%. The peak-flow meters that were used in the study were sent from the factory after manufacture and calibration. A random sample of Spirometric peak-flow meters (n = 5) were evaluated for reliability in the respiratory therapy department at the local hospital (r = .98).

The Self-Efficacy for Asthma Management Scale. Asthma self-efficacy with inhaled medications was measured by a 14-item Self-Efficacy for Asthma Management Scale (SEAMS), which was developed for this study. The range of possible scores was 0 to 100 with high scores suggesting high self-efficacy. Test-retest reliability was .82 at 2 weeks (n = 30) for pilot subjects and .82 at 6 weeks (n = 24) for subjects in the control group. Internal consistency ranged from α = .90 to α = .82.

The Asthma Self-Management Assessment Tool. Asthma self-management was measured by the self-administered Asthma Self-Management Assessment Tool (ASMAT), an adaptation of the Asthma Self-Management Competency Tool developed in 1991 by Taylor et al. The tool contained scenarios for exercise-induced asthma, respiratory tract infections, and a severe asthma attack. Subjects identified their management strategies for each of three types of asthma episodes and were awarded points on the basis of critical incidents and levels of self-management. The self-administered ASMAT had a 6-week test-retest reliability of .42 for control subjects (n = 24) with α = .78 at Time 1 and α = .76 at Time 2. The scores on the ASMAT ranged from 4 to 29. The range of possible scores was 0 to 33 with high scores signifying that subjects indicated that they had the ability to self-manage their asthma during different difficult situations.

DATA ANALYSIS

Analysis of covariance with asthma severity as a covariate was the primary statistical procedure used for the analyses of the data. Given the nonnormal distribution of all of the compliance data (a J-shaped distribution), the Mann-Whitney U Test was used to test for posttreatment differences in medication compliance between experimental and control groups.

RESULTS

Table 2 presents the baseline and posttreatment measures of central tendency and dispersion for all outcomes. No significant difference between the two groups was observed for compliance at baseline. An examination of posttreatment chronolog compliance revealed a significant difference between the two groups—with the experimental group showing a greater increase in compliance at outcome. However, there was no significant difference for self-reported compliance between the two groups at outcome. As well, no significant difference existed at baseline or posttreatment for the two groups for average total daily symptoms, percentage of symptom-free days, morning or evening peak-flow measurements, self-efficacy, or self-management.

When self-reported compliance and chronolog compliance was examined, median chronolog compliance was 37.5% as compared with a median asthma diary compliance of 93.1%. A modest correlation was documented between the two measures ($r = .44$). Of all subjects, 50% misrepresented their self-reported compliance—which suggests that self-report overestimates compliance with inhaled medications.

DISCUSSION

The findings of this study indicate that subjects who attended the 6-week self-management program increased compliance with inhaled medications compared with subjects receiving usual care. This finding was consistent with other reports of self-management programs in which medication compliance increased after the program (Bailey et al., 1990; Wilson et al., 1993). The use of an electronic monitor made it feasible to evaluate puff spacing. Most manufacturers' package inserts and teaching videos recommend that patients wait at least 1 full minute between puffs. Therefore, the information obtained from this study has important implications for the way in which asthma patients are taught regarding the use of their inhaled medications.

Another relevant finding regarding compliance with inhaled medication concerned the discrepancy between self-report

Table 2
Descriptive and Test Statistics for Outcome Variables

Outcome	Treatment $n = 31$ Pre	Treatment $n = 31$ Post	Control $n = 24$ Pre	Control $n = 24$ Post	Stat.* *(df)*
Chronolog compliance					
Mean	43	49	40	32	
Standard deviation	29	31	26	28	
Median	40	46	34	23	$U = 271$*
Range	0-100	0-100	0-83	0-88	
Average symptoms per day					
Mean	1.9	1.1	1.2	.85	$F = .284$ (1)
Standard deviation	.95	.91	.98	.93	
Median	2.0	1.0	1.1	.57	
Range	0-3.6	0-3.1	0-3.4	0-3.0	
Percentage symptom-free days					
Mean	22	44	43	60	
Standard deviation	30	38	37	37	
Median	13	38	33	64	$U = 282$***
Range	0-100	0-100	0-100	0-100	
Average peak-flow in morning					
Mean	360	359	365	364	$F = .084$ (1)
Standard deviation	105	108	137	142	
Median	351	348	351	342	
Range	150-612	188-700	140-650	250-700	
Average peak-flow in evening					
Mean	347	366	371	381	$F = .000$ (1)
Standard deviation	107	118	140	150	
Median	351	362	340	361	
Range	162-700	207-700	159-669	150-657	
Asthma self-efficacy					
Mean	58	68	54	64	$F = .104$ (1)
Standard deviation	28	22	21	20	
Median	65	73	51	65	
Range	0-100	0-95	14-100	24-100	
Asthma self-management					
Mean	18	20	18	21	$F = 1.00$ (1)
Standard deviation	6.4	6.2	5.2	5.2	
Median	20	21	19	22	
Range	5-27	4-28	5-26	12-30	

*$p < .05$. *** indicates trend $p < .1$.

compared with chronolog data. Other studies which examined the use of the chronolog and the asthma diary found that subjects overestimated their compliance behavior compared with the information obtained through the electronic monitor (Coutts, Gibson, & Paton, 1992; Gong, Simmons, Clark, & Tashkin, 1988; Spector et al., 1986; Tashkin et al., 1991). Similarly, in this study, subjects recorded information in their logs that was not corroborated by the chronolog data. Subjects may believe they are complying with inhaler use prescription, which complicates the ability to provide compliance counseling or education in self-management.

The hypothesis that subjects who attended a self-management program would experience a decrease in the frequency of daily asthma symptoms and an increase in the percentage of symptom-free days was not supported by the findings. Several explanations are possible. One is measurement sensitivity: The symptom log may not have had sufficient sensitivity to detect changes in symptom reports. A second explanation may be that the short duration of follow-up was not sufficient to see an effect of alterations in adherence. It may also be that the degree of improvement in adherence was not sufficient to produce a clinical impact. Data do not exist to evaluate the degree of compliance necessary to improve asthma symptoms.

Also, the hypothesis that airway obstruction would decrease with improved compliance was not supported by the findings. Airway obstruction was measured using morning and evening peak-flow readings. It was expected that the increase in compliance with inhaled medications would be accompanied by decreased symptoms and increased peak-flow readings. This finding has been reported elsewhere and there continues to be controversy regarding the sensitivity of peak-flow measurements (Kotses et al., 1991; Wilson et al., 1993).

Neither self-efficacy nor self-management behaviors were modified after the 6-week program. Although each instrument used was stable over time and had good internal consistency, they received limited use. Longitudinal studies that would permit an examination of time to intervention effect would be useful. The self-management programs themselves may need to be revised to target those behaviors that are most problematic for the patient with asthma.

Although the program did not appear to alter self-management behavior as measured by the ASMAT, it had some secondary

benefits. Subjects enthusiastic about being included in a study shared many experiences during group meetings concerning the lack of understanding on the part of friends, spouses, and relatives related to the diagnosis of asthma. The ability to problem solve and ventilate feelings of frustration was cited as helpful by study participants. Additionally, subjects had questions about asthma which had not been adequately addressed in busy medical practices in these rural settings. Thus, the supportive problem-solving and educational dimensions were favorably viewed by participants and have implications for clinicians. Education for patients with asthma is necessary but must be targeted to meet specific needs concerning asthma attack prevention and appropriate use of asthma medications. Even after the 6-week program, subjects were confused about which medication to use for an emergency. Nurses can provide asthma patients with information about self-management strategies to ensure appropriate use of medications and decrease morbidity and mortality of these patients.

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