

A self-management program for adult asthma. Part I: Development and evaluation

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Background: We developed and evaluated a self-management program for adult asthma. In developing the program, we considered questions of format and behavior control. The format we selected included components known to be effective in educational settings. We regulated asthma management behavior through the introduction of environmental cues.

Methods: Seventy-six subjects, whose asthma was generally under medical control, were assigned randomly to either a treatment group or a waiting-list control group. Those in the treatment group were exposed to a 7-week program that incorporated proven features of providing effective training and establishing behavioral control. Subsequently, subjects in the control group received the treatment. Short-term evaluation of the treatment was made after the subjects in the experimental group were trained but before the control subjects were trained. Long-term evaluation was conducted after both groups of subjects were trained.

Results: Over the short term, self-management training led to fewer asthma symptoms and physician visits and improvement in asthma management skills and cognitive abilities. Over the long term, self-management training was related to lower asthma attack frequency, reduced medication use, improvement in cognitive measures, and increased use of self-management skills.

Conclusions: The program improved asthma management in patients whose conditions were already under good medical control. The effects of the program were apparent a year after the conclusion of self-management training. (*J ALLERGY CLIN IMMUNOL* 1995;95:529-40.)

Key words: Adult asthma, self-management, behavioral control, environmental change

A variety of educational and self-management programs have been designed and implemented to train patients to control asthma. The goal of these efforts is to develop and foster an alliance between patient and physician in the management of asthma. Pioneer programs were developed for children with asthma; overall, the programs were successful in achieving their limited goals.¹ In recent years, a number of programs for adults with asthma have been created and tested. These pro-

Abbreviation used

PEFR: Peak expiratory flow rate

grams have entailed the application of educational processes aimed at improving the knowledge and management of asthma. The use of the programs has led to changes in a number of outcome variables, including increased knowledge of asthma,²⁻⁶ improved attitudes and perceptions toward asthma,²⁻⁶ decreased number of hospital emergency room visits^{7,8} and hospitalizations for treatment of asthma,^{3,9,10} improved medication compliance,⁹ and a reduction in both number of attacks^{4,10} and asthma symptoms.¹¹

Although all adult programs have similar objectives, teach the same basic knowledge about asthma, and address similar populations of patients, they are not identical. Programs differ in a number of ways, particularly in the way materials

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TABLE I. Sex distribution and average age of patients in both groups

Group	Male	Female	Average age (yr)
Self-management	12	24	49.7
Control	15	25	49.9

are presented and in the skills taught to patients to help regulate their asthma. Variations in two attributes, format and behavior control method, yield an array of programs differing in form, suitability for use with diverse populations, and, most importantly, effectiveness. This article reports on the effectiveness of an asthma self-management program derived and tested after questions of format and behavior control were considered.

The format of our program included three important elements: presentation of material by a highly credible individual, a small group setting, and the inclusion of written material. We selected these elements because each contributed in some way to maximizing the effectiveness of the program. Both the use of a highly credible individual as presenter¹² and a small group setting¹³ increase the efficiency of communication. The use of written material to supplement information presented orally facilitates learning of complex tasks, such as those needed for the practice of asthma self-management.¹⁴

Behavior control was presumed to be more a function of the environment than of the individual.¹⁵ In practice, this meant that we aimed to change behavior more by changing aspects of the patient's environment than by inducing change directly in the patient. To do this, we introduced cues to the patient's environment. These were represented by changes in the record of observations made by each patient in both an asthma diary and an asthma episode report form. The instruments included information on asthma symptoms, medications taken, peak flow rates obtained twice daily, and asthma precipitants. Keeping track of these variables provided individual patients with information about asthma status. The information, viewed in the context of recent asthma condition, was a signal for patients to institute activities contributing to asthma control. Our emphasis on the use of cues from written records for behavior control represented a departure from earlier management programs for adult asthma.

METHODS

Subjects

The program was offered to 126 patients with asthma. Of these, 41 declined participation and nine dropped out of the study before its completion. The remaining 76 individuals completed all phases of the study. This group included 49 women and 27 men, who, on average, described their asthma as moderate to severe. At the initiation of the study, the asthma of each patient was controlled adequately by medical treatment. The diagnosis of asthma was confirmed in accordance with standards established by the American Thoracic Society.¹⁶ Patients were not permitted to participate in the research if they exhibited one or more of the following characteristics: (1) a history of asthma of less than 6 months; (2) irreversible airway obstruction; (3) concurrent uncontrolled medical conditions; (4) asthma caused by occupational exposure; (5) alcohol, tobacco, or drug abuse; (6) obesity (>50% of ideal weight); (7) weight reduction below normal standards (<50% of ideal body weight); and (8) either cognitive or intellectual deficits likely to impair learning. The patients ranged in age from 27 to 70 years; their average age was 49.8 years (standard deviation = 12.4). The distribution of patients in both groups by age, sex, asthma duration, and seasonal asthma features is presented in Table I. All subjects read and signed a written consent form before they agreed to participate in the investigation. The study was approved by the institutional review boards at both Ohio University and the Center for Allergy and Asthma.

Subject recruitment and experimental design

The patients were assigned to one of two groups: a self-management group or a waiting-list control group. The patients in both groups participated in three operations: baseline, self-management training, and follow-up. The difference between the treatment of patients in the two groups was the duration of time spent in baseline: the patients in the self-management group were in baseline for 2 months, whereas patients in the waiting-list group were in baseline for 6 months. Self-management training was conducted during the 2 months immediately after baseline; follow-up continued for 12 months after the completion of self-management training. The difference in baseline periods between the self-management and waiting-list conditions meant that subjects in the self-management group participated in the study for a period of 16 months, and subjects in the control group participated in the experiment for a period of 20 months. Assignment of patients to groups was made randomly at the end of 2 months of baseline. At this time, individuals assigned to the self-management group were immediately scheduled for self-management training, and subjects assigned to the control group remained in baseline for an additional 4 months. The longer baseline period experienced by the control group subjects permitted group comparison at two crit-

ical periods: (1) during a 2-month period before training of either group and (2) during a 2-month period after training of the self-management group but before training of the control group. We evaluated the short-term effects of asthma self-management training by comparing changes in asthma severity from the first period to the second critical period. Between-group comparisons were based on within-subject variation. We evaluated the long-term effects of asthma self-management training by comparing measures taken at the beginning of the baseline period with measures taken at the end of the follow-up period for subjects in both groups. These comparisons were also based on within-subject variation.

Potential subjects were recruited on a continuing basis. When approximately 20 individuals had been recruited, we scheduled their participation in the study. We repeated scheduling six times, so that six groups of patients (each group consisting of both self-management and control patients) progressed at their own rate through all operations of the study. Attrition of potential subjects between the time they expressed an interest in the study and when they were actually enrolled reduced the number of subjects in each of the six groups to between 8 and 18.

Random assignment of patients to groups was unrestricted. The relatively small number of patients inducted into the study at any one time precluded implementation of matching procedures. We took account of differences between subjects by using each subject as his or her own control and by monitoring subjects for a long time. Both random assignment of subjects to groups and analysis of within-subject variability have been recommended for long-term studies of patients with asthma.¹⁷

Materials

A variety of materials were used to teach asthma self-management and to evaluate the effects of such training. Some instruments served both functions: they were used as program components and as a means of assessment. Instruments in this category included the Weekly Asthma Diary,¹⁸ the Report of Episode/Attack of Asthma,¹⁹ and the Mini-Wright Peak Flow Meter (Clement Clarke, Inc., Columbus, Ohio).²⁰ Several instruments were used exclusively for evaluation: the Basic Information Quiz,²¹ the Beck Depression Inventory,²² the Asthma Self-Efficacy Scale,²³ the Quality of Well-Being Scale,²⁴ the Revised Asthma Problem Behavior Checklist,²⁵ the Asthma Costs Workbook,²⁶ the Medical Symptom Record Form (a record of health care contacts and workdays lost because of asthma), and the General Information Form (a demographic record). All of the instruments used for evaluation had demonstrated validity and reliability, with the exception of the Asthma Costs Workbook, the Medical Symptom Record Form, and the General Information Form. The General Information Form was a bookkeeping device.

All participants received a copy of a patient manual

for asthma.²⁷ In addition, leaders of the groups received a group leader manual.²⁸

Procedure

Subjects attended an initial session during which they were given a physical examination, were evaluated for their suitability as participants, and were told the requirements of the investigation. If they agreed to participate, they were scheduled for an intake session in which they were taught how to complete self-management assessment materials and trained in the use of the Mini-Wright Peak Flow Meter. After the intake session, subjects completed the baseline, training, and follow-up operation of the study. We used baseline and follow-up periods for evaluation. Training consisted of seven 90-minute sessions during which a group leader presented and discussed topics on asthma self-management with participants. The sessions were held once a week. Topics discussed during the seven sessions included the principles of self-management, the nature of asthma, asthma medications, attack prevention, attack management, consequences of asthma, and problem solving in the management of asthma. A detailed description of the material presented in each session can be found in both the patient and group leader manuals.^{27, 28} Subjects who missed a session met privately with one of the leaders in the week before the next session to review materials presented and discussed in the group meeting. Subjects were permitted to miss no more than two of the weekly group sessions to remain in the program; if an individual missed either the first or last of the seven sessions, his or her data were not retained for analysis.

The Weekly Asthma Diary was completed for 6 months on a daily basis, beginning with the first day of the baseline period. The Weekly Asthma Diary was also completed for data recording purposes during a 2-week period at the end of the 12-month follow-up period. When subjects completed the Weekly Asthma Diary, they recorded peak expiratory flow rate (PEFR) values. They completed the Report of Episode/Attack form after each attack they experienced. The Basic Information Quiz, the Beck Depression Inventory, the Asthma Self-Efficacy Scale, the Quality of Well-Being Scale, the Revised Asthma Problem Behavior Checklist, and the Medical Symptom Record form were administered on three occasions: (1) immediately before initiation of the baseline period, (2) at the end of the sixth month of participation, and (3) at the end of the 12-month follow-up period. The Asthma Costs Workbook was completed twice: at the beginning of the study and again at the end of the follow-up period. On the basis of cost data collected, a cost-benefit analysis of the self-management program was conducted. Because of its complexity, the cost-benefit analysis is not reported here. The cost-benefit analysis is reported in detail elsewhere.²⁹ Subjects completed the General Information Form only during the intake session.

Dependent variables

The effects of asthma self-management training on five categories of variables related to asthma were evaluated. These categories included asthma symptoms, medication use, asthma-related behaviors, cognitive factors, and use of health care facilities. The measures were of two classes: dynamic and static. Dynamic or continuous measures referred to measures for which numerous observations were made throughout the program.³⁰ This class of variables included asthma symptoms, medication scores, frequency of self-management behavior, and health care facility use measures. Static measures represented those variables for which only one observation was made for each period of the study. Variables in this class were two behavioral measures (the Quality of Well-Being score and the Revised Asthma Problem Checklist score) and the cognitive measures of information, self-efficacy, and depression. The dependent variables were used to evaluate both short-term and long-term effects of self-management. Dependent variables and their use are described.

Asthma symptoms

For each recording period, the total asthma attack frequency, average PEFR score, and mean score for wheezing, breathlessness, chest tightness, and cough were determined. The average PEFR score and the mean scores for specific symptoms represented an average of all daily scores.

The asthma attack frequency score was the frequency of attacks reported in the Weekly Asthma Diary for each comparison period. To standardize the reporting of asthma attacks between subjects, each patient was provided with an operational definition of an asthma attack and with instructions to report only those exacerbations that fit the definition of an attack. Day and evening attacks were tabulated separately. Day attacks were those that occurred from waking time to 4:00 PM; evening attacks were those that occurred from 4:00 PM to waking time in the morning.

PEFR was the mean of rates reported daily in the Weekly Asthma Diary for each recording period. The morning PEFR was recorded a few minutes after a patient awoke and before morning medications were taken; the evening PEFR was recorded around 4:00 PM and before evening medications were taken. Each score recorded in the Weekly Asthma Diary represented the best value of three expiratory volume maneuvers.

The presence of wheezing, coughing, breathlessness, and chest tightness was noted daily in the Weekly Asthma Diary. Each day, patients indicated whether a particular symptom had occurred and evaluated the severity of the symptom on a scale of 0 (no discomfort) to 5 (incapacitating). For each recording period, an overall score for each symptom was calculated by averaging the daily symptom scores within the period.

Medication use

Adjusted medication scores were derived from records kept by subjects in the Weekly Asthma Diary. For each individual, a separate score for use of steroid medications, theophylline, β -agonist preparations, anticholinergic agents, and cromolyn sodium was calculated for each recording period. The various agents within each of the medication categories were scaled for potency through use of the Asthma Medication Index.³¹ To calculate a subject's daily score, the weight of the prescribed dosage was multiplied by the administration frequency. The score was then adjusted by the Asthma Medication Index factor that equated potency among medications. To obtain a subject's score for an entire recording period, all daily scores were averaged. For medications not included in the Asthma Medication Index, the potency adjustment factor was derived according to the recommendations of its manufacturer.

Asthma-related behavior

Asthma-related behaviors were evaluated through use of three instruments: the Quality of Well-Being Scale, the Revised Asthma Problem Behavior Checklist, and the Report of Episode/Attack form. The quality of Well-Being Scale and the Revised Asthma Problem Behavior Checklist assess activity limitations and behavioral consequences of asthma. The total score on each administration of both instruments was analyzed. The Episode/Attack form assessed self-management of behavior during attacks. It was completed by subjects for each asthma exacerbation during each recording period. The average number of self-management behaviors reported per asthma episode for each subject during each period was computed.

Cognitive measures

Cognitive dependent variables were the scores subjects attained on each of three questionnaires: the Basic Information Quiz, the Beck Depression Inventory, and the Asthma Self-Efficacy Scale.

Use of health care facilities

Health care facility use was measured by the number of physician visits, the number of emergency room visits, and the frequency and duration of hospitalization for treatment of asthma. These values were taken from reports made by subjects on the Medical Symptom Record Form. A score for each of the variables for each recording period was computed.

Statistical plan

To evaluate the short-term effects of asthma self-management training, changes in dependent variables from the initial 2 months of the experiment were compared with a later 2-month period (months 5 and 6). By the end of the fourth month, subjects in the self-management group had completed asthma self-management training, whereas subjects in the control group

were waiting to commence training in month 7. Therefore months 5 and 6 represented the posttraining period for subjects in the self-management group and the end of the pretraining period for subjects in the control group. We predicted improvement in the values of dependent variables in comparing the initial 2-month period with the posttraining period of months 5 and 6 for patients in the self-management group. No changes were anticipated between scores obtained at these times for subjects in the control group. To test the prediction, we conducted *a priori* contrasts between the 2 periods for both self-management and control subjects. In the analyses for asthma attack frequency, one participant was not considered because the frequency she reported departed from the mean of the group by more than 6 standard deviations.

To evaluate the long-term effects of asthma self-management training, data on dependent variables recorded at the beginning of the experiment were compared with data recorded at the end of the 12-month follow-up period. The periods were separated by 16 months for subjects in the self-management group and by 20 months for individuals in the control group. For static measures, baseline data were compared with the follow-up administration of paper-and-pencil measures. For dynamic or continuous measures, the first 2 weeks of the baseline period were compared with the last 2 weeks of the follow-up period. Changes between the baseline and follow-up periods were examined in 2×2 repeated-measures analyses of variance that tested the effects of group assignment and recording period. Because self-management training had been provided to subjects in both groups, a similar outcome for the two groups was considered evidence of the reliability of our observations.

RESULTS

Short-term effects

Asthma symptoms. Overall, asthma symptoms improved from the first 2 months to the fifth and sixth months in self-management subjects but not in control subjects. The improvements were reflected as decreased frequency of both morning ($p < 0.05$) and evening ($p < 0.01$) asthma attacks, higher morning PEFr scores ($p < 0.05$), and reductions in breathing difficulty ($p < 0.05$). From the first 2 months to the fifth and sixth months of the study, self-management patients exhibited the following reliable changes: (1) a decrease, on average, from 14.90 morning and 16.80 evening attacks in the first 2-month period to 8.50 morning and 9.80 evening attacks in the second 2-month period; (2) an increase in average PEFr from 331 L/min to 345 L/min; and (3) a decline in breathing difficulty, from 0.93 to 0.72, on a scale of 0 to 5.00. The analogous changes for the control subjects were in the same direction but were not statistically

significant. Both self-management ($p < 0.01$) and control ($p < 0.05$) subjects reported reductions in coughing symptoms from the first 2 months to the fifth and sixth months. The average coughing score dropped from 0.67 to 0.42 in self-management subjects and from 0.74 to 0.55 in control subjects. Paradoxically, control but not self-management subjects exhibited a decrease in chest tightness ($p < 0.05$). The average chest tightness score for control subjects dropped from 0.94 to 0.73. Evening PEFr scores and wheezing scores failed to change between the two recording periods for either group. The means and standard deviations of all symptom measures for subjects in both groups are displayed in Table II.

Medication. Over the short term, medication use did not change as a result of self-management training. This was expected because the subjects' asthma was generally under control at the outset of the study. The only change observed was an increase in theophylline use by subjects in the self-management group ($p < 0.05$). The rise in the adjusted theophylline score, from 4.00 to 4.50, represented an increase of about 12% in the amount of the medication taken. The adjusted medication score means and standard deviations for subjects in both groups are shown in Table III.

Asthma-related behavior. As a result of asthma self-management training, subjects in the self-management group reported short-term increases in the frequency of the performance of self-management behaviors ($p < 0.01$). The average increase was from 3.26 to 3.79 self-management behaviors per asthma attack. Subjects in the control group did not exhibit a change in the frequency of self-management behavior during the same period. Data for this comparison were gathered from the Report of Episode/Attack form. The differential effect of self-management training on the reported frequency of self-management behavior was not reported on either the Quality of Well-Being Scale or the Revised Asthma Problem Behavior Checklist; subjects in both groups showed no changes in their responses to these two instruments. The asthma-related behavior means and standard deviations of participants in both groups are shown in Table IV.

Cognitive measures. In contrast to control subjects, individuals in the self-management group showed short-term improvements in all cognitive measures after self-management training. This was reflected by an 11% increase in their knowledge of asthma, as measured by the Basic Information Quiz ($p < 0.001$), and a 13% increase in their

TABLE II. Asthma symptom means and standard deviations for patients in both groups at months 1 and 2 and months 5 and 6

Variables	Experimental period	
	Months 1 & 2	Months 5 & 6
AM attack frequency (2-month totals)		
Self-management group	14.90 ± 28.50	8.50 ± 12.60*
Control group	10.60 ± 14.80	6.40 ± 10.10
PM attack frequency (2-month totals)		
Self-management group	16.80 ± 29.00	9.80 ± 18.90†
Control group	7.20 ± 11.50	4.80 ± 7.90
AM PEF (daily average)		
Self-management group	331.00 ± 92.10	345.00 ± 88.40*
Control group	333.00 ± 123.70	341.00 ± 112.40
PM PEF (daily average)		
Self-management group	366.00 ± 86.10	367.00 ± 82.20
Control group	361.00 ± 119.60	366.00 ± 111.00
Breathing difficulty (daily average of subjective rating 1-5)		
Self-management group	0.93 ± 0.77	0.72 ± 0.79*
Control group	0.94 ± 1.02	0.80 ± 0.92
Coughing (daily average of subjective rating 1-5)		
Self-management group	0.67 ± 0.61	0.42 ± 0.56†
Control group	0.74 ± 0.83	0.55 ± 0.58*
Chest tightness (daily average of subjective rating 1-5)		
Self-management group	0.87 ± 0.66	0.74 ± 0.73
Control group	0.94 ± 0.95	0.73 ± 0.88*
Wheezing (daily average of subjective rating 1-5)		
Self-management group	0.76 ± 0.62	0.67 ± 0.77
Control group	0.65 ± 0.70	0.55 ± 0.67

AM, Morning; PM, evening.

* $p < 0.05$.† $p < 0.01$.

confidence about managing their asthma, as evidenced by scores on the Asthma Self-Efficacy Scale ($p < 0.01$). In addition, subjects in the self-management group reported reliable decreases in depression, from a score of 9.30 to 6.20, as measured by the Beck Depression Inventory ($p < 0.001$), whereas subjects in the control group did not. The average depression scores of subjects in the experimental group, as well as those of subjects in the control group, were entirely within the normal range of values, indicating that the subjects were not clinically depressed either before or during the study. Therefore apart from signaling a small elevation in mood, the depression change we noted was not clinically significant. The means and standard deviations of the cognitive dependent variables are included in Table IV.

Use of health care facilities. Subjects in the self-management group exhibited a decrease in frequency of physician visits from the baseline period to the posttraining period ($p < 0.05$), whereas subjects in the control group did not. The change was modest, from 2.94 to 2.13 visits throughout a two-month period. Other measures of health care facility use, however, were not sensitive to self-management training. This was reflected by the lack of significant changes between the baseline and posttraining periods in number of emergency room visits and the frequency and duration of hospitalizations for treatment of asthma. The means and standard deviations of health care facility use practices are shown in Table V. It should be noted that the overall frequencies for the number of emergency room visits and hospi-

TABLE III. Adjusted medication score means and standard deviations for patients in both groups at months 1 and 2 and months 5 and 6

Variables	Experimental period	
	Months 1 & 2	Months 5 & 6
Steroid medication		
Self-management group	11.90 ± 14.50	10.30 ± 14.40
Control group	15.10 ± 14.40	16.00 ± 14.40
Theophylline		
Self-management group	4.00 ± 3.00	4.50 ± 3.20*
Control group	4.60 ± 3.40	4.70 ± 3.60
β ₂ -Agonist preparations		
Self-management group	3.00 ± 2.50	3.10 ± 2.30
Control group	3.20 ± 2.80	2.60 ± 2.50
Anticholinergic agents		
Self-management group	0.45 ± 1.22	0.63 ± 1.77
Control group	0.43 ± 1.16	0.45 ± 1.13
Cromolyn sodium		
Self-management group	1.56 ± 2.18	1.41 ± 1.74
Control group	1.01 ± 1.67	0.90 ± 1.40

* $p < 0.05$.

TABLE IV. Cognitive and behavioral test score means and standard deviations for patients in both groups at months 1 and 2 and months 5 and 6

Variables	Experimental period	
	Months 1 & 2	Months 5 & 6
Basic information quiz		
Self-management group	37.00 ± 5.10	41.40 ± 3.60*
Control group	36.50 ± 4.40	37.50 ± 4.70
Beck Depression Inventory		
Self-management group	9.30 ± 8.00	6.20 ± 6.70*
Control group	9.30 ± 9.20	8.50 ± 8.30
Asthma Self-Efficacy Scale		
Self-management group	246.00 ± 63.20	277.00 ± 51.80†
Control group	263.00 ± 70.40	277.00 ± 66.60
Quality of Well-Being Scale		
Self-management group	5.00 ± 0.59	5.20 ± 0.60
Control group	5.10 ± 0.55	5.20 ± 0.67
Revised Asthma Problem Behavior Checklist		
Self-management group	160.20 ± 36.40	157.10 ± 34.86
Control group	151.70 ± 28.80	145.50 ± 36.20
Frequency of Self-Management Behaviors		
Self-management group	3.26 ± 0.93	3.79 ± 1.40†
Control group	3.49 ± 1.35	3.36 ± 1.40

* $p < 0.001$.

† $p < 0.01$.

talizations for treatment of asthma were low. The low frequency of hospitalizations for treatment of asthma influenced the statistical outcome of this variable. However, it should be reiterated that the subjects' asthma was generally under medical control at the beginning of the study.

Long-term effects

Asthma symptoms. Asthma attack frequency during the morning hours decreased for subjects in both groups from the initial 2 weeks of the baseline period to the final 2 weeks of the follow-up period ($p < 0.05$). The decrease averaged 3.10 attacks,

TABLE V. Frequency of use of health care facility: Means and standard deviations for patients in both groups at months 1 and 2 and months 5 and 6

Variables	Experimental period	
	Months 1 & 2	Months 5 & 6
Physician visits		
Self-management group	2.94 ± 3.08	2.13 ± 3.97*
Control group	1.67 ± 1.90	1.83 ± 2.15
Emergency room visits		
Self-management group	0.01 ± 0.08	0.03 ± 0.11
Control group	0.01 ± 0.08	0.04 ± 0.14
Hospitalization frequency		
Self-management group	0.08 ± 0.41	0.03 ± 0.11
Control group	0 ± 0	0.01 ± 0.08
Hospitalization duration		
Self-management group	0.06 ± 0.40	0.03 ± 0.11
Control group	0 ± 0	0.03 ± 0.16

* $p < 0.05$.

from 4.50 to 1.40, for the self-management patients, and 1.28 attacks, from 2.10 to 0.82 for the control patients. Other symptoms of asthma did not change between periods; there were also no differences between groups. Symptoms in this category included evening asthma attacks; morning and evening PEFR; and patient evaluations of breathing difficulty, coughing, chest tightness, and wheezing. The means and standard deviations of asthma symptoms are presented in Table VI.

Medications. Subjects in both groups reported a decrease in use of both β_2 -agonists ($p < 0.05$) and cromolyn sodium ($p < 0.01$) from the initial 2 weeks of the baseline period to the last 2 weeks of follow-up period. Overall, there was about a 35% decrease in the use of β_2 -agonist preparations and about a 50% decrease in use of cromolyn sodium. Steroid, xanthine, and anticholinergic medication intake did not change between periods; there were also no differences between groups. The means and standard deviations of all adjusted medication scores are given in Table VII.

Asthma-related behavior. According to scores on the Revised Asthma Problem Behavior Checklist, subjects in both groups ($p < 0.01$) reported fewer asthma-related problems at the end of the follow-up period than they did at the beginning of the baseline period; the decrease in scale values was about 6%. Differential responding on the questionnaire, however, was not reflected by responses on the Report of Episode/Attack form. Subjects in the two groups performed about the same number of self-management behaviors during the final 2 weeks of the follow-up period as they did during the initial 2 weeks of the baseline period. In

addition, Quality of Well-Being Scale scores did not change between recording periods, nor did they differ between groups. The measures and standard deviations of all asthma-related behaviors are presented in Table VIII.

Cognitive measures. Improvement was noted in all cognitive measures from the baseline period to the follow-up period. Subjects in both groups demonstrated more knowledge of asthma ($p < 0.05$), reported less depression ($p < 0.001$), and said they were more confident about their ability to manage their asthma during the follow-up period than during the baseline period ($p < 0.001$). In terms of overall percentage changes, we observed a 6% increase in knowledge, a 31% decrease in depression scores, and a 15% increase in self-efficacy scores. The reliability of these observations was supported by the analyses of Basic Information Quiz scores, Beck Depression Inventory scores, and Asthma Self-Efficacy Scale scores. The analyses yielded no significant group effects or interactions. The means and standard deviations of all cognitive measures are shown in Table VIII.

Use of health care facilities. Subjects in the two groups did not demonstrate changes in the number of physician visits they made from the initial 2 weeks of the baseline period to the final 2 weeks of the follow-up period. This outcome likely reflected the fact that the subjects' asthma was under control at the outset of the study. Other measures of health care facility use were infrequently reported, thereby precluding meaningful statistical analyses. The measures in this category were number of emergency room visits and the frequency and duration of hospitalizations for treatment of asthma. The means

TABLE VI. Asthma symptom means and standard deviations for patients in both groups at baseline and follow-up periods

Variables	Experimental period	
	Baseline	Follow-up
AM attack frequency (2-week totals)		
Self-management group	4.50 ± 8.80	1.40 ± 2.70*
Control group	2.10 ± 3.50	0.82 ± 1.20*
PM attack frequency (2-week totals)		
Self-management group	4.20 ± 9.10	0.38 ± 0.90
Control group	1.60 ± 2.20	1.58 ± 2.60
AM PEF (daily average)		
Self-management group	312.00 ± 81.0	332.00 ± 88.00
Control group	345.00 ± 120.00	345.00 ± 131.00
PM PEF (daily average)		
Self-management group	351.00 ± 78.00	367.00 ± 68.00
Control group	355.00 ± 129.00	358.00 ± 121.00
Breathing difficulty (daily average of subjective rating 1-5)		
Self-management group	0.89 ± 0.91	0.63 ± 0.70
Control group	0.89 ± 0.91	1.17 ± 1.11
Coughing (daily average of subjective rating 1-5)		
Self-management group	0.73 ± 0.78	0.32 ± 0.54
Control group	0.71 ± 0.89	0.61 ± 0.91
Chest tightness (daily average of subjective rating 1-5)		
Self-management group	0.83 ± 0.91	0.57 ± 0.79
Control group	0.75 ± 0.74	0.74 ± 1.00
Wheezing (daily average of subjective rating 1-5)		
Self-management group	0.65 ± 0.68	0.47 ± 0.63
Control group	0.86 ± 1.07	1.03 ± 1.08

AM, Morning; PM, evening.

* $p < 0.05$.

and standard deviations of all health care facility use measures are given in Table IX.

DISCUSSION

A wide variety of outcome measures related to asthma severity changed as a result of self-management training. This was reflected by: (1) a decrease in asthma symptoms, including fewer asthma attacks, higher peak flow rates, and lower patient ratings of breathlessness; (2) an increase in asthma self-management behaviors; (3) changes in cognitive measures, including increased knowledge of asthma and higher self-efficacy and lower depression scores; and (4) a decrease in the number of physician visits. The results showed that self-management can have a significant positive effect on the severity of asthma.

Short-term assessment was limited to a 2-month period after self-management training. This period was selected to balance the conflicting demands of

extended observations with an anticipated attrition of patients, had they remained longer as control subjects. In almost all studies of the self-management of asthma,¹ patients assigned to a control group failed to remain in such a condition beyond 6 months, a period equal to the time required in this study to usher the subjects in the experimental group through baseline, training, and 2-month follow-up periods. The lack of attrition of subjects from the waiting-list control group indicates that the length of time selected in this study remains appropriate for asthma self-management research.

To assess long-term effects of asthma self-management training, subjects in the experimental group were compared with control subjects at the time they completed all phases of the research program. As described earlier, the measures obtained on the completion of all research requirements were taken at different times for individuals

TABLE VII. Adjusted medication score means and standard deviations for patients in both groups at baseline and follow-up periods

Variables	Experimental period	
	Baseline	Follow-up
Steroid medication		
Self-management group	10.30 ± 15.90	9.00 ± 13.70
Control group	13.30 ± 11.30	12.70 ± 14.30
Theophylline		
Self-management group	4.42 ± 4.11	3.28 ± 3.24
Control group	4.66 ± 3.84	4.16 ± 5.18
β ₂ -Agonist preparations		
Self-management group	2.55 ± 2.17	1.68 ± 1.90*
Control group	2.78 ± 2.76	1.75 ± 2.00*
Anticholinergic agents		
Self-management group	0.48 ± 1.28	0.44 ± 1.08
Control group	0.28 ± 0.96	0.39 ± 1.24
Cromolyn sodium		
Self-management group	1.20 ± 1.78	0.50 ± 0.91†
Control group	1.10 ± 1.64	.65 ± 1.10†

p* < 0.05.†*p* < 0.01.TABLE VIII.** Cognitive and behavioral test score means and standard deviations for patients in both groups at baseline and follow-up periods

Variables	Experimental period	
	Baseline	Follow-up
Basic Information Quiz		
Self-management group	37.00 ± 5.19	39.50 ± 7.70*
Control group	36.50 ± 4.48	38.50 ± 9.97*
Beck Depression Inventory		
Self-management group	9.30 ± 8.00	6.55 ± 8.98†
Control group	8.69 ± 8.40	5.89 ± 7.17†
Asthma Self-Efficacy Scale		
Self-management group	246.60 ± 63.20	289.90 ± 59.30†
Control group	261.00 ± 68.40	294.00 ± 65.40†
Quality of Well-Being Scale		
Self-management group	5.12 ± 0.59	5.12 ± 1.10
Control group	5.06 ± 0.56	6.06 ± 4.75
Revised Asthma Problem Behavior Checklist		
Self-management group	160.20 ± 36.40	150.90 ± 33.30‡
Control group	155.40 ± 23.80	146.00 ± 28.80‡
Frequency of Self-Management Behaviors		
Self-management group	3.70 ± 1.10	4.20 ± 1.60
Control group	3.40 ± 1.00	3.80 ± 1.20

**p* < 0.05.†*p* < 0.001.‡*p* < 0.01.

in the two groups. It was predicted that assessment at these times would show that individuals in the two groups, though dissimilar after only one of the two groups of subjects was trained, would be

similar in their performance of self-management skills after both groups received training. The predictions were supported in that after training of both groups, subjects showed similar changes with

TABLE IX. Frequency of use of health care facility means and standard deviations for patients in both groups at baseline and at follow-up periods

Variables	Experimental period	
	Baseline	Follow-up
Physician visits		
Self-management group	0.55 ± 0.96	0.61 ± 0.84
Control group	0.48 ± 0.87	0.66 ± 0.81
Emergency room visits		
Self-management group	0.04 ± 0.20	0
Control group	0.04 ± 0.20	0
Hospitalization frequency		
Self-management group	0.04 ± 0.20	0
Control group	0	0
Hospitalization duration		
Self-management group	0.21 ± 1.02	0
Control group	0	0

respect to: (1) reduction of asthma attacks; (2) reduction of β_2 -agonist and cromolyn sodium use; and (3) improvement of cognitive and behavioral indices, including knowledge of asthma, depression, self-efficacy, and asthma problem-solving behaviors. The similarity in performance between subjects assigned to the experimental and control groups at the completion of the research suggested that asthma self-management training had long-term effects.

Improvements in asthma severity experienced by subjects can be attributed to both educational procedures and development of self-management behavior. In selecting educational procedures, we chose those formats that optimized communication and learning. In fostering development of self-management behavior, we taught patients to use aspects of records they maintained to prompt asthma management measures. Both the application of effective educational procedures and the use of patient records as cues for self-management behavior appear to be responsible for the strong results we obtained. The findings suggest that the effectiveness of an asthma self-management program may be determined by the behavioral and educational principles incorporated into its design. It is anticipated that progress in asthma self-management will derive from increased sophistication in the application of behavioral control procedures and educational technology.³²

A final point should be emphasized. This study was unique in that almost all of the subjects enrolled were receiving appropriate medical attention before they entered the study; as a result, their asthma was generally under control. Positive changes that occurred in their asthma over the

course of their participation were an indication of their acquisition and subsequent performance of self-management skills. Thus unlike conclusions of previous research, changes that occurred in outcome measures cannot be attributed to improved medical management that usually occurs concurrently with and as a component of self-management training. Rather, the positive changes indicate that patients enhanced the medical treatment they received by learning and performing asthma self-management skills.

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