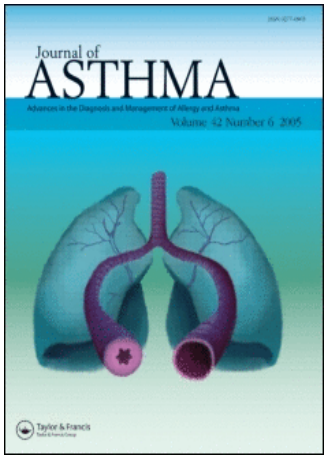

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ORIGINAL ARTICLE

The Pediatric Asthma Intervention: A Comprehensive Cost-Effective Approach to Asthma Management in a Disadvantaged Inner-City Community

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Objective. To compare three pediatric asthma interventions for their impact on improving the health status of inner-city asthmatic children and in achieving cost savings. *Study Design*. A total of 212 children 1 to 16 years of age were randomized into three groups: group 1 ($n = 74$) received one individualized asthma education session; group 2 ($n = 68$) received reinforced asthma education; group 3 ($n = 70$) received reinforced asthma education plus case management. Asthma-related health resource utilization and cost were primary outcomes. The cost-benefit analysis sought to estimate the expected cost savings to the Illinois Department of Healthcare and Family Services (Medicaid administrator) associated with the intervention. *Results*. Participants in all three groups used significantly fewer emergency health care services in the follow-up year. Averaged across all three groups, the magnitudes of declines were substantial: 81% for hospitalizations, 69% for hospital days, 64% for emergency department visits, and 58% for clinic visits. Although there were no statistically significant differences between study groups for three of the four main outcome measures, group 3 participants consistently improved to the greatest degree. All three interventions were associated with considerable cost savings ranging from $4,021/child/year for group 1 to $4,503/child/year for group 3. *Conclusion*. Asthma education with or without case management services enhances the health of children with asthma thereby reducing associated costs.

Keywords asthma, health education, case management, hospitalization, emergency room

INTRODUCTION

Approximately 9 million children (12%) in the United States have been diagnosed with asthma, of which nearly half have experienced an asthma attack in the previous year (1). Over the past decade, our knowledge of how to best manage asthma has substantially improved, yet the morbidity and mortality associated with this disease for minority disadvantaged children living in inner-city environments have continued to increase at an alarming rate (2, 3).

Nowhere is the impact of childhood asthma more acutely felt than in the inner-city neighborhoods of Chicago, where the rate of hospitalizations for asthma is 2.3 times higher than the national average (42.8 per 10,000 as compared to 19.5 per 10,000) (4). Likewise, Chicago's asthma mortality rate exceeded the nation's in every age category from 1990–1997 (4). Asthma also has a significant impact on quality of life, lost wages, and medical costs (5). In 1999 an estimated 1.4 billion dollars were spent in Illinois on direct medical care expenditures for asthma (6).

In 1997, the National Asthma Education Prevention Program Expert Panel Report II Guidelines described the four components necessary for an effective asthma management program (7). The fourth component emphasizes education and an active partnership with patients. To adequately manage asthma, the patient and family must be able to make appropriate judgments about a variety of daily activities, including medication use, trigger avoidance, following an asthma action plan, and responding to an attack. The interactive education of both the patient and his or her caregiver is a necessary part of developing and successfully implementing an asthma action plan.

There are still wide disparities associated with approaches to asthma management and control, with minority, poor, and inner-city children experiencing a disproportionate asthma burden (3, 8–12). Finkelstein et al. reported that of 1,648 Medicaid-insured pediatric patients, 73% underused their

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[1]Johnson D, Karnick P, Seals G, Margellos H, Silva A, Whitman S, Castro A, Aljadeff G, Burrage J, O'Connor T, Wolf R, and Miller L for the Chicago Pediatric Asthma Initiative. Randomized study of the impact of intensive asthma education (iAE), with/without case management (CM), on the health of inner city asthmatic children: Preliminary results. Platform presentation at 2002 Pediatric Academic Societies' Meeting, Baltimore, Maryland, May 7, 2002, Abstract 1234.

[2]Margellos H, Johnson D, Karnick P, Silva A, and Whitman S. A randomized controlled trial of the impact and cost-effectiveness of intense individualized asthma education with and without case management on the health status of inner-city children with asthma: A Pediatric Asthma Initiative. Oral presentation at 130th Annual Meeting of American Public Health Association, Philadelphia, PA November 9–13, 2002, Abstract 41651.

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controller medications (12). The authors cited several contributing factors including lack of parental education, inadequate access to health care resources, and lack of an asthma action plan.

In an attempt to improve the health of inner-city children with asthma, the Department of Pediatrics at Sinai Children's Hospital initiated a randomized trial to compare three interventions. We hypothesized that the most economical path to improving the health status of inner-city children with asthma would be through a system of reinforced health education sessions combined with case management services.

METHODS

Study Design

This study was designed as a sequential randomized clinical trial. Participants included children between 1 to 16 years of age with asthma. Children with other chronic conditions in addition to asthma were excluded from participation. Study participants were recruited between July 2000 to May 2001 from Mount Sinai Hospital's emergency department (ED), from inpatient units, and from patients referred to Sinai's pediatric pulmonologist for consultation. Data were retrospectively collected for one year before the study and prospectively for 9 months after enrollment.

The study protocol was reviewed and approved by the Institutional Review Board. Informed consent was obtained from each participant's parent or legal guardian.

All participants were first evaluated by our pediatric pulmonologist to confirm their asthma diagnosis and level of severity per the guidelines and to assess their eligibility for study inclusion. Patients' treatment plans were altered by the pediatric pulmonologist on study entry to meet National Heart, Lung, and Blood Institute (NHLBI) treatment guidelines (7).

The study team consisted of a pediatric pulmonologist, a pediatric nurse practitioner, an asthma lay health educator trained to provide asthma education and collect data, a research assistant, and an epidemiologist.

Randomization

The patients were randomized into three groups.

Group 1 (Asthma Education Group). The asthma educator provided participants and their caregivers with basic asthma education. This education consisted of one individualized 20 to 30-minute session, which included information on basic asthma pathophysiology, recognition of triggers, principles of therapy including review of medications and the difference between rescue and controller medications, and the use of an asthma treatment plan. Medication and equipment use was tailored to the participant's individual needs. If participants in this group needed any further guidance or information regarding their care, treatment, or asthma management, they were referred to their primary care provider.

Group 2 (Reinforced Education Group). Participants and their caregivers received the same initial asthma education as group 1. However, their education was reinforced as needed and at a minimum during the monthly data collection telephone calls (after the data had been collected). Participants in this group were encouraged to call the asthma educator if they had questions.

Group 3 (Case Management and Reinforced Education Group). Participants received the same reinforced asthma education as did those in group 2. However, group 3 participants also had case management services available to them. A nurse practitioner/case manager completed an initial case management evaluation on all group 3 participants. The nurse practitioner/case manager worked collaboratively with the family to identify problems and needs and to devise a solution action plan. Generally, the health educator supported the family in carrying out the case management plan. The nurse practitioner supervised the health educator and was contacted on an as-needed basis to resolve case management issues and problems beyond the capacity of the health educator.

Data Collection and Analysis

Data were collected retrospectively for one year before the study and prospectively on a monthly basis for 9 months after enrollment. Data collection occurred either by telephone or face-to-face interviews. Data collected at baseline included: demographics, information on the frequency and severity of asthma symptoms, frequency of rescue medication use (e.g., albuterol), and asthma-related health care utilization (hospitalizations, hospital days, ED visits, and clinic visits) during the preceding year. For school age children, information was also collected on the number of school days missed. All the aforementioned data were based on caregiver report, and the same information was collected monthly for the duration of the 9-month follow-up period. The research assistant and asthma lay health educator shared responsibility for data collection.

Asthma-related health resource utilization (hospitalizations, hospital days, ED visits, and clinic visits) served as the primary outcome variable. The total number of hospitalizations, hospital days, ED visits and clinic visits for the 9-month follow-up period was calculated by summing the individual monthly follow-up values. If a follow-up was missed, the information regarding health resource utilization for a particular month was recaptured during the next month's follow-up telephone call. However, the amount of time over which data could be recalled was limited to less than 3 months, to minimize bias. In situations where a monthly data point was missing, the missing data point was filled in with the participant's average value. We extrapolated follow-up data to one year's time to make it comparable to baseline data. The change (difference) between the average number of hospitalizations, hospital days, ED visits, and clinic visits from the baseline to follow-up year served as the unit of analysis for the main outcome variables.

Cost Benefit Analysis

Since Medicaid insured 89% of enrolled children, the cost-benefit analysis sought to estimate the expected cost savings to the Illinois Department of Healthcare and Family Services (IDHFS) resulting from the intervention. The average reimbursement by Medicaid for asthma-related hospitalizations ($5,865), ED visits ($132), and clinic visits ($19) during FY 1998 for children living in Mount Sinai's primary service area were obtained and used in estimating expenditure. It was also determined that during FY 1998, Medicaid spent an average of $164 on asthma medications per child with asthma living

in Mount Sinai's primary service area. Therefore this amount was included in the estimate of asthma-related expenditures for the baseline year.

Medication costs increased in the follow-up year for most participants. Before enrollment, the majority of study participants were not on a controller medication. The pulmonologist prescribed an inhaled steroid and a beta-agonist to most participants during the baseline visit. As a result, participants' medication costs increased in the follow-up year. In 1998 IDHFS paid between $461 to $723/child/year for children who were on an inhaled steroid, beta-agonist, and rescue medication. The high end of this range was added to the health care costs for the follow-up year to assure that our cost savings estimates erred on the conservative side. As participants in all three study groups were seen by a pulmonologist on enrollment into the study, the reimbursement for this initial visit (~$50) was also included in the health care costs for the follow-up year.

The average cost savings to IDHFS for health utilization could then be approximated by subtracting the average level of reimbursement during the follow-up period from the average during the baseline period. The cost savings were calculated separately for each of the three study groups.

Finally, the cost of conducting the intervention was subtracted from the cost savings. The amount of time spent on various activities by the health educator/case manager were available and made it possible to more accurately estimate the cost of conducting the intervention in each of the three study groups. Besides the salary of the health educator/case manager, start-up and operating costs ($5,000) were also incorporated into the program costs. The average cost of conducting the program with those who were eventually lost to follow-up was also integrated into each group's program costs.

Statistical Analysis

Population demographics and baseline data were compared across study groups by using Chi-Square or Fisher's Exact test for categorical variables and analysis of variance (ANOVA) for continuous variables. Paired *t* tests were used to assess the statistical significance of within group changes from the baseline to follow-up year. The between group differences were assessed for statistical significance by ANOVA. For all statistical tests, a *p*-value of less than 0.05 was considered statistically significant. Two-sided tests of hypothesis were used. All statistical analyses were performed using SAS statistical software, version 8.2 (13).

RESULTS

There were 212 participants who agreed to take part in the study, and of these, 165 (77.8%) completed the 9-month follow-up. Those completing were evenly distributed across study groups. The baseline characteristics of participants in each group are displayed in Table 1. There were no significant differences among the groups with the exception of the number of unscheduled clinic visits in the baseline year. The average child had nearly 2 ED visits and 1 hospitalization for asthma in the baseline year.

The average participant completed 8.7 of the 9 monthly follow-ups (range 6 to 9). There were no significant differences in the number of follow-ups completed by study group, race/ethnicity, or age (data not shown). Participants were considered lost to follow-up after repeated attempts to contact them using various means (telephone, written communication, etc.) were unsuccessful for three consecutive months.

TABLE 1.—Baseline characteristics of participants enrolled in Sinai's Pediatric Asthma Intervention by study group ($n = 212$).

	Group 1 ($n = 74$)	Group 2 ($n = 68$)	Group 3 ($n = 70$)	*p*-value*
Gender				
Male	55%	66%	59%	NS
Female	45%	34%	41%	
Race/Ethnicity				
Non-Hispanic black	70%	65%	64%	NS
Hispanic	30%	35%	34%	
Other	0%	0%	1%	
Age				
1–4	54%	57%	44%	NS
5–12	38%	35%	46%	
>12	8%	7%	10%	
Age (mean)	5.54	5.13	5.71	NS
Insurance				
None	3%	0%	0%	NS
Medicaid	86%	90%	91%	
HMO/Private	11%	10%	9%	
Parent's education (mean)‡	12.24	12.00	12.14	NS
Symptoms				
Daily	0%	0%	3%	NS
2–6 times a week	80%	82%	79%	
once a week or less	20%	18%	19%	
Albuterol use (rescue med)				
Daily	9%	10%	14%	NS
2–6 times/week	45%	46%	44%	
once a week	32%	24%	17%	
< once a week/rarely	14%	21%	24%	
Healthcare utilization (one year pre-intervention)				
ED Visits (mean)	1.87	1.62	2.10	NS
Hospitalizations (mean)	1.01	1.03	1.07	NS
Hospital days (mean)	2.11	2.04	2.53	NS
Unscheduled clinic visits (mean)	2.53	2.53	3.46	<.05
School days missed (mean)†	6.65	5.38	6.62	NS

*Chi-Square/Fisher as appropriate was used to assess significance of categorical variables; ANOVA for continuous variables. NS = "not significant" (p >0 .05).
†Only applicable to children ≥ 5. n = 34, 29 & 39 respectively for Groups 1,2 and 3.
‡2 Group 1 participants were missing this information.

Health Resource Utilization

Table 2 displays the average number of hospitalizations, hospital days, ED visits, and clinic visits during the baseline and follow-up years for those completing the study ($n = 165$). When compared with the baseline year, all four of the health resource utilization outcomes in each of the three study groups improved significantly (paired *t* test, $p < 0.05$).

When comparing differences in the degree of improvement among the three study groups, only clinic visits were statistically significant. Group 3 reported an average decrease of 2.8 visits between the baseline and follow-up year as compared to about 1.2 for groups 1 and 2 (ANOVA, $p = 0.0001$). In the case of hospital days, group 3 improved nearly twice as much as group 1 or group 2 (-2.26 *vs.* -1.13 and -1.20, respectively), but this difference did not achieve statistical significance ($p = 0.14$). While there were no significant differences between study groups for three of the four main outcome measures, in all cases group 3 improved most.

Cost Benefit Analysis

Table 3 shows the estimated asthma-related health care reimbursement by IDHFS for study participants in each group

TABLE 2.—Asthma-related health resource utilization in the baseline and follow-up period and the associated change by study group ($n = 165$).

	Group 1 ($n = 55$)	Group 2 ($n = 54$)	Group 3 ($n = 56$)	p value (ANOVA)
Hospitalizations*				
Baseline	1.02	1.00	1.09	.77
FU	0.24	0.19	0.15	
Difference	−0.78	−0.81	−0.94	
%change	−76%	−81%	−86%	
p value†	<.0001	<.0001	<.0001	
Hospital days*				
Baseline	2.05	1.83	2.63	.14
FU	0.92	0.63	0.37	
Difference	−1.13	−1.20	−2.26	
% change	−55%	−66%	−86%	
p value*	<05	<.005	<.0001	
ED Visits*				
Baseline	1.86	1.54	2.14	.25
FU	0.89	0.54	0.55	
Difference	−0.97	−0.99	−1.59	
% change	−52%	−65%	−74%	
p value†	<.05	<.0005	<.0001	
Clinic visits*				
Baseline	2.55	2.39	3.57	.0001
FU	1.40	1.22	.75	
Difference	−1.16	−1.17	−2.82	
% change	−45%	−49%	−79%	
p value†	<.0001	<.0001	<.0001	

*Average of total hospitalizations/days/visits over one year. Baseline data is from the year before the intervention. Follow-up data was extrapolated to represent 1 year's time.
† $p$value for comparison of baseline to follow-up values (within group changes). Compared using paired t test.

during the years before and after the intervention. As all three study groups experienced significant decreases in health resource utilization between the baseline and follow-up year (Table 2), it is not surprising that all three also experienced substantial decreases in health care reimbursement, ranging from $4,115/child/year in Group 1 to $5,166/child/year in group 3.

Table 3 also displays the costs associated with conducting the intervention, and the remaining cost savings after accounting for program spending. Substantial cost savings resulted from the intervention in all three study groups. The cost savings were the greatest for participants in group 3 ($4,503/person) as compared to group 1 ($4,021/person) or group 2 ($4,140/person).

Given that it is more expensive to fund reinforced health education or case management, cost savings per dollar spent were most dramatic for group 1 ($44 saved/dollar spent). However, both reinforced education (group 2, $28 saved/dollar spent) and reinforced education plus case management (group 3, $8 saved/dollar spent) also resulted in substantially greater savings than spending.

DISCUSSION

All intervention participants improved dramatically and significantly between the baseline and follow-up year on all of the outcomes assessed regardless of study group. The average decline in utilization of health resources across all three groups was substantial: roughly 81% for hospitalizations, 69% for hospital days, 64% for ED visits, and 58% for clinic visits. As a result, the cost savings associated with the intervention were also considerable. The improvement in all three groups suggests that even the most basic intervention, in this case a one-time, case-specific, one-on-one asthma education session with a trained lay health educator, can improve asthma control among disadvantaged children with severe asthma. While there were no statistically significant differences in outcomes between study groups, the trend of group 3 participants improving to a greater degree than group 1 or group 2 participants was consistent across all outcomes. While a portion of the improvement may be related to regression to the mean, the degree of the improvement makes it unlikely that such a phenomenon solely explains the findings.

The magnitude of our results is similar to those reported by Kelly et al. (14) who conducted an intervention similar to that provided to our group 2 and 3 participants in a similar population (inner-city, Medicaid insured, 94% Black). In their study the improvements in health resource utilization for the intervention group were of a magnitude similar to those seen in our groups 1 and 2. Since all their subjects were recruited because they had been seen in the ED at least twice in the past year for asthma or had been hospitalized for asthma at least once in the preceding year, they recruited a population with more room for improvement than our population. Yet our participants improved to a similar or greater magnitude.

TABLE 3.—Estimated asthma-related healthcare costs of participants in the year before and following the intervention, program costs, and overall cost savings.

	Group 1 ($n = 55$)		Group 2 ($n = 54$)		Group 3 ($n = 56$)	
	IDHFS reimbursement ($)/child/year		IDHFS reimbursement ($)/child/year		IDHFS reimbursement ($)/child/year	
	Pre	Post	Pre	Post	Pre	Post
Asthma-related healthcare						
ED Visits	245.52	117.48	203.28	71.28	282.48	72.60
Hospitalizations	5,982.30	1,407.60	5,865.00	1,114.35	6,392.85	879.75
Clinic Visits	47.28	25.96	44.31	22.62	66.19	13.91
Medications	164.00	723.00	164.00	723.00	164.00	723.00
Pulmonologist	0	50.00	0	50.00	0	50.00
Total healthcare costs	6,439.10	2,324.04	6,276.59	1,981.25	6,905.52	1,739.26
Healthcare cost savings ($)*	4,115.06		4,295.34		5,166.26	
Cost of program/person ($)	94.30		155.30		662.83	
Program cost-savings/person ($)†	4,020.76		4,140.04		4,503.44	
Cost savings/$ spent on the program ($)‡	43.64		27.66		7.79	

*Cost savings due to differences in asthma-related health care costs between the year before and after the intervention. Costs and savings were estimated using the average reimbursement for asthma-related health care by the Illinois Department of Healthcare and Family Services in 1998.
†Program Cost Savings = Healthcare Cost Savings – Cost of Program.
‡Cost Savings per $ spent = Healthcare Cost Savings/Cost of Program.

Other studies have also supported the utility of individualized, case-specific asthma education and case management provided by health professionals (e.g., nurses), social workers, lay health educators, and others in improving asthma outcomes (15–20).

Calculated cost savings in the study groups ranged from $4,000 to $5,000/person/year. This is substantially higher than cost savings reported in association with other pediatric asthma health education interventions, which have ranged from $721/person/year (14) to $1,437/person/year (17). Our cost-benefit analysis focused on cost expenditures by a payer for healthcare services (i.e., IDHFS) rather than on hospital expenditures, which was the perspective used in the other cited studies. Collective evidence consistently points towards cost savings from interventions aiming to improve asthma management by improving patient and family asthma knowledge (14–15, 17). Although our intervention included a supervising nurse practitioner, we believe that a well-trained and experienced community health educator could effectively perform the case management activities without a supervising nurse practitioner. This would lower the cost for the case management intervention by approximately $200 per patient (data not shown), resulting in even greater cost savings than those presented in Table 3. As a result, the cost savings would increase to $30.46 per dollar spent for group 2, and $13.29 per dollar spent for group 3.

To illustrate the magnitude of these savings, we present the following example. To fund a community health educator in Chicago for one year would cost approximately $35,000. Another $5,000 would be expected in start-up and operating costs. Therefore, we would expect to invest approximately $40,000/year for a community health educator. Based on the figures presented here, by investing that initial $40,000, IDHFS could anticipate saving approximately $1.8 million if the group 1 intervention were used, $1.2 million if the group 2 intervention were used and $531K if the group 3 intervention were used.

It should also be noted that the analysis calculated cost savings based on average asthma expenditure by Medicaid in 1998. Given the cost of medications and medical treatment have increased significantly since that time, the estimated cost savings today would be considerably greater.

In the current intervention, all group 3 participants were provided with case management services. Case management was a dynamic and systematic approach to providing and coordinating health care services. A participative process to identifying and facilitating service options for meeting individuals' needs was utilized, with the goal of decreasing fragmentation and duplication of care, enhancing quality, and promoting cost effective responses. The average participant required only 10.8 hours of case management over the course of 9 months, with a range of 2 to 78 hours (data not shown). Future interventions could maximize both health outcomes and cost savings by screening participating families and targeting case management activities to those who might most benefit from them.

Methodological Considerations

Funding constraints limited the amount of time that we were able to follow enrolled participants to 9 months. As such we needed to extrapolate 12 months of data from 9 months in order to compare it to the 1-year baseline data. In Chicago and elsewhere, a trend has been shown to exist in which most asthma-related hospitalizations and ED visits occur in the fall months, and fewest in the summer months (4, 21). To assess whether a seasonal effect may have impacted our findings, the follow-up data were pooled and categorized by season. There were no significant differences in the proportion of participants who reported at least one hospitalization or ED visit or in the average number of hospitalizations, hospital days, or ED visits by season of follow-up (data not shown).

Our study is also limited by the fact that the baseline data were collected retrospectively and that all data were collected via participant recall. Therefore the ability of the caregivers to accurately remember information may have affected our evaluation findings (i.e., recall bias). Also, social desirability bias may have been a factor given that the health educator was responsible for some of the data collection. However, given the events reported on herein (e.g., ED visits, hospitalizations) are traumatic and generally memorable, and given the extent of improvement between the baseline and follow-up year, we are confident that the overall conclusion of the evaluation was not impeded on by these limitations.

An additional limitation of this study is that the interpretation of our results is complicated by the fact that all study participants saw a pulmonologist on enrollment, making it difficult to separate out how much of the noted improvement among participants was due to health education/case management and how much was due to changes in medical management. However, evidence has consistently pointed to the need for education in addition to the proper prescribing of medications in properly managing asthma. First, while studies have shown that poor children with persistent asthma living in urban areas under use controller medications, it has not been determined whether provider prescribing practices or parental/family factors are to blame for this underuse (22–23). Caregivers of poor inner-city black children with asthma participating in focus groups identified parental/family factors rather than provider factors as the greatest barrier to proper asthma management. They also overwhelmingly acknowledged modifying the asthma management plan prescribed by their child's physician because of their own health beliefs (e.g., fear about long-term medication use and side effects) and their lack of knowledge about how to properly use the prescribed medications (24). Caregivers also reported that the education they had received on medication use from their physician was not provided in a way that they could comprehend (24). Both the NHLBI guidelines (7) and an expert panel report of policy recommendations (25) also emphasize the importance of health education/case management in addition to better prescribing in maximizing asthma control. It is therefore unlikely that the dramatic improvements noted herein would have been observed with medication changes alone.

Implications

Primary care providers face many obstacles to applying the NHLBI asthma treatment guidelines to patient care, particularly in the inner-city where reimbursement for services

often is at or below the cost of delivering quality care. Realistic mechanisms and incentives are needed to ensure that patients receive care consistent with the NHLBI standards. Medicaid funding support for health education, with or without case management, is a realistic program for improving quality of life and asthma care in the inner-city while reducing public expenditures.

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