

An intervention program to reduce the hospitalization cost of asthmatic patients requiring intubation

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Background: Asthma is the single disease that accounts for the largest proportion of total health care cost in the US.

Objective: To analyze whether an asthma management program affected the cost of subsequent asthma care for patients in whom intubation had been necessary.

Methods: We evaluated patients with asthma who (1) had required intubation for treatment of status asthmaticus; (2) were 45 years old or younger; (3) had regular follow-up visits in our clinic for 1 year after initial evaluation; and (4) had complete medical records 1 year before and 1 year after the intervention for our evaluation. Medical costs of asthma treatment for each patient were determined for 1 year before and 1 year after intervention.

The program included patient education, regular outpatient visits, specialist care, and access to the Allergy Immunology emergency call service. The outcome measures were the total cost of care, inpatient hospitalizations, outpatient services, emergency services, and medicine costs.

Results: Nine patients [mean age 19.6 years (SD = 9.9)] fulfilled the criteria (six women and three men). The mean duration of asthma was 14.0 years (SD = 9.7). The mean total cost of care decreased from \$43,066 to \$4,914 ($t = -4.53, P < .001$) and inpatient hospitalization costs decreased from \$40,253 to \$1,926 ($t = -4.50, P < .001$). There was, however, no significant difference in the mean pre-intervention versus post-intervention cost of emergency services, outpatient services, or medicine costs.

Conclusions: The intervention—which included education, specialist care, regular outpatient visits, and access to an emergency call service—significantly reduced the cost of asthma care in our population of patients intubated for asthma.

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INTRODUCTION

Asthma is a common chronic disease affecting approximately 10 million people in the United States (US).¹ The prevalence, morbidity, and mortality of asthma have increased in the US and

other western countries over the last two decades.^{2,3} In addition, the cost of asthma care in the US also has increased. No other single disease accounts for a larger proportion of the total health care costs in the US.⁴

Asthma health care expenditures in the US exceeded 4 billion dollars in 1988⁵ and were estimated at 6.2 billion dollars in 1990.⁴ Of 6.2 billion dollars, approximately 1.6 billion dollars was attributed to inpatient hospital services⁴ and approximately 2.7 billion dollars was due to emergency room use, hospitalization, and premature death.⁴

Efforts to reduce the cost of asthma care through several educational programs have been reported.⁶⁻¹² None-

theless, there have been no previous studies evaluating the cost of asthma care in patients who have required intubation. Accordingly, the objective of our study was to analyze whether an asthma management interventional program affected the cost of asthma care for high risk patients with asthma in whom intubation had been necessary.

MATERIALS AND METHODS

Patient Identification

Patients were identified by a review of charts of patients who were managed by the Allergy and Immunology Division at Northwestern University Medical School from 1982 to 1992 with the diagnosis of potentially fatal asthma.¹³ Potentially fatal asthma criteria identify patients who are at high risk of fatal asthma. The criteria for potentially fatal asthma include at least one of the following: (1) intubation for respiratory arrest or failure; (2) respiratory acidosis without intubation; (3) two or more hospitalizations despite oral corticosteroids given for an exacerbation (0.5 to 1 mg/kg prednisone); or (4) two or more episodes of pneumothorax or pneumomediastinum associated with status asthmaticus.¹³

Patients with the following criteria were selected for this study: patients with asthma who (1) had required intubation previously for treatment of status asthmaticus; (2) were 45 years old or younger when first examined by the Allergy-Immunology Service; (3) had regular follow-up visits in our clinic for one year after initial evaluation; and (4) for whom we were able to obtain complete medical records one year before and one year after the in-

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intervention. These patients met American Thoracic Society and National Institute of Health definitions of asthma.¹⁴

Data Obtained

From the medical records, the following information was obtained for 1 year before and 1 year after intervention:

1. The number, duration, and severity of hospitalizations (admission to the medical intensive care unit with or without mechanical ventilatory support or to the general medical floor).
2. The number of emergency room visits.
3. The number of office visits and outpatient laboratory services.
4. The number, frequency, and duration of usage of antiasthma medications.

Calculations of Cost Estimations (in 1992 US dollars)

1. Inpatient hospitalization expenditures were calculated by multiplying the number of days that the patient was hospitalized by the estimated charge to the patient for standard care per day in an urban hospital in Chicago (Table 1). In this manuscript we equate costs with charges.
2. Emergency services costs were calculated by multiplying the number of visits by the cost of standard care in an urban hospital emergency room. This calculation excluded the initial emergency room visit prior to that admission

Table 1. Standard Cost of Care Per Day in an Urban Hospital in Chicago, Illinois (in 1992 US Dollars)

Care Provided	Cost
Medical intensive care unit with mechanical ventilatory support	\$6421.00
Medical intensive care unit without mechanical ventilatory support	\$5761.00
Semiprivate room on a general medical floor	\$2167.00
Emergency room visit for asthma	\$1409.00

that was assigned to the category in Table 1.

3. Outpatient services included all asthma related outpatient visits and outpatient laboratory tests (Table 2).
4. Medicine costs were calculated by summing the costs of each of the antiasthma medications. The costs assigned to each particular medication were those charged by a large chain of pharmacies in the Chicago area.
5. The total cost of care is the sum of the costs of inpatient hospitalization, outpatient services, emergency visits, and medications.

A telephone survey of other urban hospitals in Chicago revealed that the costs for different services in this study are relatively comparable across hospitals. Furthermore, the order of magnitude in the differences in the cost of inpatient hospitalization versus the other categories of care examined in this study are representative across hospitals.

Intervention

The intervention program employed in the present study has been described elsewhere.¹⁵ Important aspects of the intervention included emphasis on patient education, specialist care, regular, scheduled outpatient visits (initially frequent office visits from weekly to monthly then decreasing in frequency as the asthma improved; frequent office visits during periods of asthma exacerbations), and access to the emergency call service (a 24-hour call number for instructions and early treatment of asthma exacerbations). Patient education consisted of discussions concerning: (1) the basic pathophysiology of asthma and the diagnosis of potentially fatal asthma; (2) allergen avoid-

ance; (3) discontinuation of smoking; (4) the use of antiasthma medications; (5) uses, abuses, and early use of oral corticosteroids for changes in respiratory status as directed by physicians; (6) maximal use of inhaled corticosteroids; (7) metered dose inhaler technique; (8) preparation for surgery and travel instruction; and (9) the importance of compliance with office visits and therapy.

Treatment Approach

On initial evaluation, a complete medical and allergy-immunology history was obtained followed by a physical examination. Some important information in the history included IgE-mediated triggers of asthma, smoking status, previous pneumonias, emergency room visits, hospitalizations, and intubations.

In addition to skin testing to common aeroallergens, if indicated other tests such as chest roentgenograms, spirometry, serum theophylline concentrations, and serology for allergic bronchopulmonary aspergillosis were obtained. Metered dose inhaler techniques were also evaluated.

The treatment plan included (1) allergen avoidance, (2) maximal use of inhaled corticosteroids, (3) beta-adrenergic agonists by inhalation dosages to eight scheduled inhalations per day, (4) initially high-dose daily prednisone (60 mg/day) with conversion to alternate-day for long-term maintenance and tapered off slowly depending on the severity of the symptoms, (5) early use of prednisone for exacerbations of asthma, and (6) annual influenza immunization.

Patients were instructed to call if their asthma symptoms worsened or if they needed to use their β agonist inhaler more. Oral corticosteroids were initiated in patients whose asthma symptoms were significantly worse, not relieved by inhaled β agonist, or required more than recommended dose of β agonist.

Statistical Analysis

The mean cost of medical care for a 1-year period after compliance with

Table 2. Outpatient Services Itemized Cost (in US Dollars)

Service	Cost
Office visit	\$58.00
Chest radiograph	\$69.00
Theophylline serum concentration	\$51.00
Office spirometry	\$25.00

the intervention program was compared with the mean cost of medical care for the previous year in nine patients using within-subjects *t* test.¹⁶ Dunn's Bonferroni-type multiple comparisons procedure¹⁷ was employed in order to ensure an experimentwise type I error of $P < .05$. Since a total of five tests of statistical hypotheses were conducted in this study, the adjusted alpha criterion was thus $0.05/5 = 0.01$. Accordingly, statistical tests with a corresponding $P < .01$ were considered statistically significant at an experimentwise $P < .05$.

RESULTS

From January 1982 to December 1992, 21 patients were identified who were age 45 years or younger and had asthma severe enough to require intubation. Seven of 21 patients left our clinic within the first year and therefore were excluded. Three of the seven patients (42.8%) died within 1 year after leaving our service. Fourteen patients were treated in our clinic for at least 1 year. Of these patients, three (21.4%) were lost to follow-up so that we were unable to obtain releases of complete medical records in the year prior to intervention. Two additional patients were unable to obtain their medical records because their former physicians (the primary physician before the patient enrolled in our allergy service) had died or relocated.

The characteristics of the remaining nine patients (six women and three men) are presented in Table 3. These

patients had a mean age of 19.6 years (SD = 9.9) and they had had asthma for a mean of 14.0 years (SD = 9.7). In the year before the intervention every patient required one intubation except for patient number 2 (0 intubations) and patient number 3 (2 intubations). In the year after the intervention, however, no patient required an intubation. All patients in this study were judged by their attending physician to be compliant based on their regular follow-up visits, apparent use of prescribed medications, and appropriate use of the emergency call service.

All patients except for patient number 6 were managed by other physicians when they had asthma severe enough to require intubation. Patient number 6 apparently used only a beta-adrenergic agonist during acute asthma exacerbations leading to respiratory failure.

The total cost per year for each patient is shown in Figure 1 for the year before and the year after intervention. The mean cost per year for all patients for inpatient hospitalization, medications, outpatient services, and emergency services is depicted in Figure 2 for the year before and after intervention. The comparison of all costs for both years and the statistical analyses of the differences are listed in Table 4. The mean total and hospitalization costs were significantly lower after management by our service (Table 4). There was, however, no significant difference in the mean pre-admission versus post-admission costs of emergency

services, outpatient services, or medications.

At year end, all nine patients were alive. Two patients had experienced hospitalizations but no intubations. The mean number of medications used the year before intervention was 7.0 (SD = 16.3) versus 6.0 (SD = 4.3) for the subsequent year. Six patients were receiving low-dose alternate day prednisone and one patient was receiving low dose daily prednisone (10 mg/day). None of the seven patients was using a corticosteroid. Two other patients were being managed without prednisone. All nine patients were receiving an inhaled corticosteroid, five patients were receiving theophylline, and eight patients were receiving beta-adrenergic agonists.

DISCUSSION

The health care costs in the US have increased from 13.2% of GNP in 1991 to 14% in 1992, according to the Commerce Department estimate.¹⁸ In 1993, the health care bill was 942.5 billion dollars and the projected health cost in 1994 is 1,060 billion dollars.¹⁹ Efforts to reduce morbidity and mortality of many diseases such as asthma have been studied. The main outcome measures of asthma studies were reduction of hospitalizations and emergency room visits.⁶⁻¹¹ Most of these studies reported efficacy of patient education in both adults and children⁶⁻¹¹; however, one study reported no change in asthma morbidity as measured by the frequency of exacerbations, nocturnal

Table 3. Characteristics† of High Risk Patients with Asthma

Patient	Age,* yr	Sex	Race	Yr of Asthma	Tobacco Used	Education Level	Specialty of Previous Physician
1	17	F	C	15	Y	10th grade	Family practitioners
2	26	F	C	11	N	College	Internist
3	8	F	C	3	N	3rd grade	Allergist/pediatrician
4	31	M	A	20	Y	High school	Internist
5	12	M	C	9	N	7th grade	Pediatrician
6	21	F	C	10	N	College	Allergist
7	30	M	C	29	N	College	Allergist
8	4	F	C	2	N	Not available	Pediatrician/allergist
9	27	F	C	27	N	High school	Pulmonologist/allergist

* At presentation.

† F = female, M = male, C = Caucasian, A = African-American, Y = yes, and N = no.

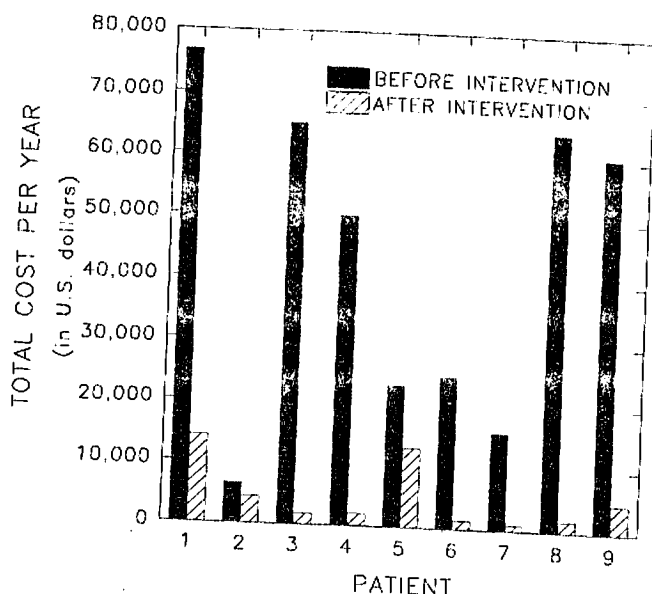


Figure 1. The total costs (in US dollars) of care for each patient are illustrated for the year before and after intervention.

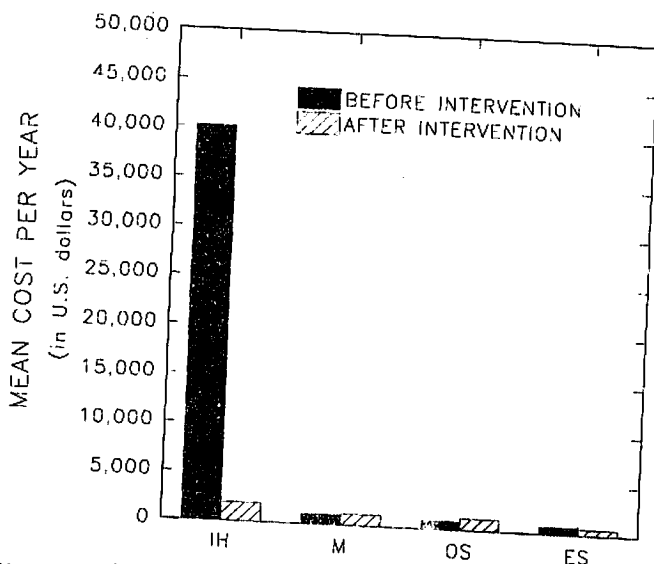


Figure 2. The mean cost for inpatient hospitalization, medications, outpatient services, and emergency services is shown for all patients for the year before and after intervention.

symptoms or number of home visits for asthma (the educated group did have improvement in knowledge and fewer emergency room visits).¹² In that study, there was one unfortunate death in the untreated group. The key elements of success in these studies were patient educational programs, accessibility of the physician, and provision for follow-up assessment and care after hospitalization.

Our interventional program also emphasized these factors with instructions provided by direct physician-patient involvement. Other consideration in treating these patients included a simplified medical regimen, early use of prednisone for increases in respiratory symptoms, and maintenance alternate day prednisone therapy if prolonged use was essential. We encouraged the use of our 24-hour call number for

early treatment of asthma exacerbations. We also emphasized compliance and monitored behaviors in this context during regular outpatient visits. Our treatment program utilized physicians experienced with administration of prednisone.

In order to exclude from our study those patients who had other chronic respiratory diseases such as emphysema, we only evaluated patients who were 45 years old or younger and who did not have emphysema. Because it was difficult to obtain complete medical information more than 1 year prior to entering the intervention program, and it would have been less representative to obtain information less than 1 year, we analyzed data obtained 1 year before entering our intervention program and 1 year later.

In our study, the mean total cost of care (\$43,066 versus \$4914 in 1992 US dollars/per person/per year) of hospitalizations was significantly lower after intervention. There were no significant differences in the mean pre-intervention versus post-intervention cost of emergency services, outpatient services, or medications. We hypothesize that the reason there were no differences in the latter "small ticket" cost categories was because the severity of illness in this sample of patients necessitates intensive therapy including significant medication, regular outpatient visits, and acute emergency care. That is, these patients are heavy medical resource utilizers irrespective of whether or not they are hospitalized. As shown in Tables 1 and 4, the cost of standard asthma care *per day* in the medical intensive care unit is twice as much as the sum of the mean cost of outpatient services, emergency services, and medications *per year*. Prevention of respiratory arrest requiring mechanical ventilation and medical intensive care admission clearly reduces morbidity, mortality, and a major portion of the cost of asthma care. The intervention program reduces the most costly health care resources used by this population of patients with severe asthma.

Table 4. Comparing Costs* One Year Before Versus After Admission to the Allergy Service for the Total Sample

Source of Cost	Year Before		Year After		t	P<
	Mean	SD	Mean	SD		
Hospitalization (number)	40253 (1.5)	26352	1926 (0.2)	3973	-4.50	0.002
Emergency Services	783	1024	626	1024	-0.55	0.60
Outpatient Services	939	703	1203	597	0.94	0.38
Medicine	1091	608	1159	615	0.50	0.64
Total	43066	25637	4914	5030	-4.53	0.002

* Costs are in 1992 dollars (\$US). A negative value of t indicates that the mean cost decreased after admission. A positive value of t indicates that the mean cost increased after admission.

Despite a history of intubation for asthma, overall costs of medical care were reduced and mortality was prevented in those patients who participated in the intensive intervention program. The patients who did not receive continuous treatment for asthma could be viewed as an untreated group resulting in three deaths in the seven patients who chose not to receive care by our service.

The reasons why some patients are noncompliant have been the subject of a variety of studies.²⁰⁻²⁴ Some reasons include psychologic factors,²⁵ environmental and social factors,²⁶ difficult therapeutic regimens,²⁷ lack of physician-patient communication,²⁸ the patient's or their parent's degree of education,²³ and/or acceptance of the seriousness of the disease.²⁹ One study reported that mothers with more than 8 years of formal education were more compliant regarding the medication regimen for asthmatic children than mothers with fewer years of education.²³ Future research should examine the potential benefit of supplemental asthma educational programs³⁰ in enhancing patient compliance.

Although the present study indicates that the direct costs of asthma care were clearly reduced, it is not clear what component of the intervention was most effective. We did not analyze indirect costs. One might hypothesize that the improvement may be attributed to the use of inhaled corticosteroids rather than the whole intervention program. In deference to this hypothesis, even though inhaled corticosteroids have been recommended and utilized by physicians for asth-

matic patients for more than a decade, asthma morbidity and mortality have continued to increase. The intervention program emphasized daily prednisone administration initially to reduce symptoms and improve respiratory function with subsequent conversion to alternate day therapy. Future research involving larger groups of patients examined for a longer period of time should be conducted in order to determine the relative efficacy of the different intervention components.

To our knowledge, this is the first study evaluating the cost of asthma care with an intervention program in patients with potentially fatal asthma who had required intubation. The study is limited by the small number of patients and by the absence of a formal control group. More studies of this type are clearly needed in order to improve the delivery of healthcare by promoting awareness among physicians to include cost in evaluating outcome studies. Our program emphasizes education, regular outpatient visits, 24-hour emergency call services, and care by physicians skilled in management of complex patients with asthma who require prednisone. As demonstrated, in compliant patients, the goals were achievable not only in preventing death and hospitalization, but also in sharply reducing the overall cost of asthma care.

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