Results of a Program to Improve the Process of Inpatient Care of Adult Asthmatics*

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Objectives: To assess the effectiveness of a program to improve care of adult patients hospitalized for asthma.

Design: Retrospective analysis of patient and house staff education, patterns of medication use, spacer use, peak flowmeter use, and length of stay before and after team intervention.

Setting: A 960-bed teaching hospital in New York City.

Patients: All patients admitted to the hospital with a primary diagnosis of acute asthma exacerbation for 2 separate similar calendar periods, 1 year apart, before and after program intervention. We excluded patients who were hospitalized for less than 24 h or greater than 10 days. The preintervention group comprised 61 patients and the postintervention group 65 patients, well matched in their demographic characteristics and severity of disease.

Interventions: Using a team approach, we analyzed the process of inpatient treatment of asthma exacerbation, identified root causes for quality deficiency, and implemented specific improvements in the process. These included dedicated nurses who focused on the education of care providers and patients, a personalized attending-intern educational approach, and improvement in the supply and delivery of spacers, peak flowmeters, and medications to the patients.

Results: There was a significant increase in use of spacers, peak flowmeters, and inhaled corticosteroids. Systemic corticosteroid and methylxanthine use declined. Length of stay was reduced without increasing early hospital readmission rates.

Conclusions: This program improved the treatment process of adults hospitalized for asthma. (CHEST 1996; 110:48-52)

Key words: asthma education treatment

Abbreviations: BIMC=Beth Israel Medical Center; LOS=length of hospital stay; MDI=metered-dose inhaler

Epidemiologic studies of New York City show that certain small geographic areas have very high death rates and hospitalization rates for asthma.1,2 These areas, conveniently defined by zip codes, are socioeconomically depressed and have large black and Latino populations.2 They have hospital admission rates that are up to ten times higher than the national average, and usually fall within the catchment areas of a few large municipal and voluntary hospitals that care for large numbers of inpatient adult asthmatics. This report describes the organization, application, and effect of a quality improvement program targeted at the treatment process of inpatient adult asthma in an inner city hospital serving an area of high asthma prevalence.

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Manuscript received August 7, 1995; revision accepted February 9, 1996.

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Materials and Methods

Beth Israel Medical Center (BIMC) is a 960-bed teaching hospital that draws many of its patients from the lower east side of Manhattan, a geographic area and population that has hospital admission and death rates for asthma that are above the national average.3,4 BIMC has approximately 400 adult asthma hospital admissions and 3,000 Emergency Department visits for asthma per year. Eighty percent of hospitalized asthmatics have no private physician and are cared for by 120 medical house officers supervised by the attending faculty. This study was approved by the institutional committee on scientific activities.

Team Development

The asthma team consisted of a core group of five persons: a physician with expertise in quality management, a pulmonologist, an allergist with expertise in asthma, a nurse practitioner, and a nurse educator. Personnel from house staff, respiratory therapy, central supply, medical records, warehouse, and pharmacy were involved as needed. Initial team meetings involved analysis of the existing system for treating hospitalized asthmatics, including patient education, house staff training, and the supply and delivery of medicines, spacers, and peak flowmeters. From these analyses, the team identified opportunities for improvement and prioritized...
them according to the estimated degree that they would improve the overall treatment process.

Three areas of opportunity were identified. First, there was no consistent method of providing effective education to the patients, nor was there a method of assuring timely outpatient visits after hospital discharge. Second, the house staff’s knowledge of asthma management was suboptimal. Finally, there was inappropriate variation in treatment. The house staff varied widely in their use of medicines, spacers, and peak flowmeters, despite a concerted effort by the attending staff to educate them. The variability in treatment was exacerbated by problems with the supply and delivery of medicines, spacers, and peak flowmeters to the patient care units.

Team Function

In January 1992, the asthma team completed their analyses of the treatment process and proposed the following improvements.

*Patient Education and Follow-up:* Adult patients admitted to the hospital with the primary diagnosis of asthma (International Classification of Disease code 493.90-93) who had no private physician were evaluated by a team nurse within 24 h of hospital admission, or on the first weekday following holiday or weekend admission. If the patient fulfilled standard criteria for asthma, a detailed note was left in the chart to guide the house staff. The nurse and the patient had an intensive educational session that emphasized pathophysiology, self-management guidelines, and instruction in the use of a metered-dose inhaler (MDI), spacer, and peak flowmeter. Whenever possible, the session was repeated the next day. On hospital discharge, the patient was given an appointment to a specialized asthma clinic within 1 week. This clinic was established as a result of the team’s recommendation. If there were difficult management issues, the team physicians were available to the nurses for immediate consultation.

*House Staff Education:* The two attending physicians were responsible for house staff education with the goal of developing their skills in the treatment of severe asthma. One of them contacted each intern who admitted a patient with asthma, and arranged a meeting that lasted approximately 45 min. It included a detailed discussion of management, and hands-on training in the use of the MDI, spacer, and peak flowmeter. The intern was also given a spacer and MDI for patient education. Since asthma was a common reason for hospital admission, interns usually had more than one session with an attending physician. These sessions supplemented formal lectures. A special effort was made in the early part of the academic year to teach all interns.

*Treatment:* The team developed specific guidelines that were reviewed in detail with the intern in charge of each case. The use of the guidelines was optional, and included treatment strategies that were quite different from previous practice at BIMC. The guidelines for acute treatment of asthma are as follows: methylprednisolone, 40 mg IV every 6 h for the initial 24 h, with further use of IV corticosteroids determined by house staff judgment; prednisone, 40 mg by mouth once daily upon discontinuation of methylprednisolone therapy (generally at 24 h after hospital admission); triamcinolone (Azmacort) via MDI, 10 puffs (200 pg per puff) twice daily as tolerated within 24 h of hospital admission; the spacer provided with this medication was discarded, and all patients were trained with a collapsible reservoir spacer (InspirePro; Key Pharmaceuticals, Summit, NJ); albuterol via jet nebulizer as needed while the patient was acutely dyspneic; albuterol therapy, 4 puffs every 4 h using an MDI with a spacer under direct patient control, was started as soon as possible; IV aminophylline not used; peak flow measured at least daily; discharge from hospital when peak flow greater than 60% predicted if clinical assessment correlated; prednisone dosage reduced rapidly if patient deemed likely to be adherent with high-dose inhaled triamcinolone; prednisone dosage reduced slowly if the patient used oral corticosteroids long term; and clinic appointment scheduled within 7 days of hospital discharge.

### Data Analysis

We compared two calendar periods 1 year apart, before (preintervention) and after (postintervention) introduction of the asthma program. A 5-month period starting November 1, 1991 was compared to an identical calendar period in 1992, after the program had been in operation for 9 months. We attempted to review the records of all adults with a primary diagnosis of asthma (International Classification of Disease code 493.00-493.91) who did not have a private medical physician (service patients). Patients hospitalized for less than 24 h or longer than 10 days were excluded because of the high likelihood that the first group probably did not require hospital admission, and that the second group was likely to have a severe comorbid illness.

The two asthma team nurses summarized the records using a standard data collection form. By plan, patients were categorized into one group who had uncomplicated asthma, and another who had asthma as the primary admitting diagnosis but who had a complicating comorbid illness such as major cardiovascular disease or pneumonia. Assignment of a category was by agreement of the chart reviewers. Thirty-day hospital readmission rates were calculated based on review of records obtained from the hospital’s medical information system database. Information on the clinical background of study patients did not include the patients’ histories of previous hospitalizations, as these data are unreliable because of the lack of a city-wide database.

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**Table 1—Demographic and Clinical Characteristics of Patient Groups, Before and After Asthma Program Intervention**

<table>
<thead>
<tr>
<th>Age, yr, mean±SD</th>
<th>Gender, M:F</th>
<th>Race/ethnicity, Hispanic:Black:white</th>
<th>History of substance abuse, No. (%)</th>
<th>History of smoking, No. (%)</th>
<th>History of intubation, No. (%)</th>
<th>Initial peak flow, L/min, mean±SD</th>
<th>Duration of asthma, yr, mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong> (n=61)</td>
<td><strong>After</strong> (n=65)</td>
<td><strong>Before</strong> (n=43)</td>
<td><strong>After</strong> (n=45)</td>
<td><strong>Before</strong> (n=18)</td>
<td><strong>After</strong> (n=20)</td>
<td><strong>Before</strong> (n=45)</td>
<td><strong>After</strong> (n=45)</td>
</tr>
<tr>
<td>40±12.4</td>
<td>40±13.0</td>
<td>39±11.8</td>
<td>39±13.0</td>
<td>45±12.6</td>
<td>43±12.7</td>
<td>167±60.3</td>
<td>177±80.9</td>
</tr>
<tr>
<td>50:54</td>
<td>49:60</td>
<td>35±3:3</td>
<td>35:3:5</td>
<td>15:3:1</td>
<td>14:3:3</td>
<td>6:10</td>
<td>14:3:3</td>
</tr>
<tr>
<td>4:7</td>
<td>9:14</td>
<td>178±70.8</td>
<td>178±70.8</td>
<td>17±13.1</td>
<td>22±14.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.01.

**p<0.02.**
Table 2—Education and Treatment Characteristics Before and After Asthma Program Intervention

<table>
<thead>
<tr>
<th></th>
<th>All Asthma (Admissions)</th>
<th>Uncomplicated Asthma (Admissions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before (n=72)</td>
<td>After (n=72)</td>
</tr>
<tr>
<td>Patient education, No. (%)</td>
<td>22 (31)</td>
<td>52 (72)</td>
</tr>
<tr>
<td>House staff education, No. (%)</td>
<td>0 (0)</td>
<td>24 (34)</td>
</tr>
<tr>
<td>Peak flow by house staff, No. (%)</td>
<td>30 (42)</td>
<td>51 (77)</td>
</tr>
<tr>
<td>Spacer use by patient, No. (%)</td>
<td>27 (38)</td>
<td>61 (85)</td>
</tr>
<tr>
<td>IV corticosteroids, mean daily dose, mg</td>
<td>206</td>
<td>175</td>
</tr>
<tr>
<td>IV corticosteroids, mean duration, d</td>
<td>3.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Oral corticosteroids, mean hospital day started</td>
<td>3.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Inhaled corticosteroids, No. (%)</td>
<td>46 (64)</td>
<td>71 (99)</td>
</tr>
<tr>
<td>Inhaled corticosteroids, mean hospital day started</td>
<td>2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>IV aminophylline, No. (%)</td>
<td>48 (67)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Oral theophylline, No. (%)</td>
<td>64 (89)</td>
<td>12 (17)</td>
</tr>
<tr>
<td>LOS, mean days</td>
<td>4.8</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Statistics

All data was analyzed using software (Epi Info Version 5.01b; Public Domain Software for Epidemiology and Disease Surveillance; Centers for Disease Control and Prevention; Atlanta). Data were evaluated using the χ², the Student’s t test, and the Wilcoxon two-sample test as appropriate. Length of stay (LOS) data were evaluated using the unpaired Student’s t test.

RESULTS

From November 1991 through January 1992 (pre-intervention), there were 78 service admissions that fulfilled eligibility criteria. Seventy-two charts were available for review; these hospital admissions were generated by 61 patients. Forty-three patients (60%) had asthma uncomplicated by other serious illness. From November 1992 through January 1993 (post-intervention), there were 78 eligible admissions. The records of 72 hospitals admissions were available for review, generated by 65 patients. Forty-five patients (63%) had asthma uncomplicated by other serious illness. The characteristics of all patients are presented in Table 1. There were discernible but minor differences between the groups in gender and smoking history only in patients with uncomplicated asthma.

Educational efforts and patterns of medical treatment are shown in Table 2. The function of the asthma team was evaluated by reviewing the number of house staff and patient education sessions documented in the medical record. The postintervention group demonstrated increased nurse-patient and attending-intern sessions. Compared with treatment before the asthma program, the postintervention group also showed increased use of peak flow measurements and spacers. The dose and duration of IV corticosteroid administration fell significantly, patients were switched to oral corticosteroids earlier, and more patients were given inhaled corticosteroids. IV aminophylline use stopped completely, and oral theophylline use declined. LOS was reduced by a mean of 0.8 days (17%) in all patients, and by 1.2 days (26%) in the patients with uncomplicated asthma. In the same calendar periods, LOS for all medical service patients fell by 0.5 days (4%), from 12.3 days to 11.8 days. The 30-day hospital readmission rates for patients with asthma were uniformly low, without significant differences between the two groups (Table 3).

DISCUSSION

This study reports the results of a program to improve the treatment process of adults hospitalized for acute exacerbations of asthma. For 3 years before the program was started, we attempted to improve inpatient treatment patterns using group didactic lectures, teaching rounds, and distribution of National Asthma Education Program guidelines to all house staff. The treatment patterns reported in the preintervention patients are the result of vigorous teaching efforts by a few attending physicians. Despite these efforts, the treatment of patients with asthma remained suboptimal, as others observed in a large hospital. We therefore formed an asthma team to improve the inpatient treatment process.

We developed specific plans to improve patient education, house staff education, and medical management. To assess the effects of the intervention, we...
compared two identical calendar periods 1 year apart to avoid seasonal variation in disease activity and house staff competence. The groups were similar in their available demographic and clinical characteristics, but the pattern of medical care changed significantly following the intervention. We increased the use of inhaled corticosteroids, peak flowmeters, and spacer devices while decreasing the use of IV corticosteroids and methylxanthines.

Nurse-patient education sessions were an integral part of the program. We believe that the inpatient setting is the best time to educate patients in outpatient self-management. The hospitalized patient is likely to be better motivated due to the immediacy of severe illness, and sessions occur without the time constraints and distractions common in a busy outpatient service. These sessions already occurred in the preintervention period, because some patients were recruited into an existing outpatient clinic by the nurse practitioner. However, these numbers of sessions increased significantly following the program. Nurses did not see every patient because of weekend and holiday admissions. While they prepared the patients for a smooth transition to early ambulatory follow-up at the asthma clinic, we did not measure preintervention and postintervention clinic attendance rate.

The house staff was educated using a strategy of "academic detailing" that is labor intensive but appeared to be very effective. The 37% reported rate of attending-house staff educational sessions in the postintervention period is an artifact of measurement later in the academic year. Because these sessions began to be measured 4 months after the start of the academic year, attending staff were disinclined to pursue house staff who were already trained. We anticipate that individualized house staff education will develop a hospital-wide expertise in asthma management, and that incoming house staff will eventually be trained effectively by their supervisory residents.

Guidelines were developed based on team consensus and the available literature, and were used to improve treatment patterns. The guidelines encouraged individualized management strategies based on the severity of disease and response to treatment. They also reduced inappropriate variation of medical care. Adherence to guidelines by the house staff was entirely voluntary, and depended on their accepting the logic of the proposed regimen. We believe that mandatory application of guidelines may be counterproductive and violate the cooperative principle of the educational process. With this in mind, the guidelines were presented in a nonauthoritarian manner during house staff training sessions, and the asthma team did not write orders.

Quality of care has many components, one of which is LOS. Comparing the preintervention and postintervention periods, LOS decreased by 0.8 days (17%) overall, and by 1.2 days (26%) in patients with uncomplicated asthma. Patients with a major complicating illness did not have a decrease in LOS, probably because the LOS was determined by the complicating illness. The reduction in LOS has several possible causes. An educated house staff may be more secure in their assessment of patient condition and timing of hospital discharge. Early high-quality outpatient care also gives confidence to the discharging physician. If an outpatient clinic visit on the day after hospital discharge were guaranteed, it is likely that LOS could be safely reduced further. The reduction in LOS that occurred in uncomplicated postintervention service patients has significant cost implications in a diagnosis-related group environment. LOS of all medical service patients for the two calendar periods did not change, suggesting that asthma LOS did not decrease only because of hospital-wide initiatives. Rather, it was the result of the asthma team intervention.

The program would be counterproductive if a reduction in LOS was associated with an increase in the early hospital readmission rate. Among study patients, readmissions within 30 days for asthma were very low, and identical in the two periods. There is no reliable method to track readmission rates citywide, but our experience indicates that patients prefer to return to the same hospital.

Although the data indicate that the asthma program had beneficial effects, there were methodologic limitations in this study. Data were obtained by retrospective chart review; ideally, a clinical team should design a lead-in period of careful prospective evaluation before initiating the improvement strategy. The lack of a simultaneous house staff control group is also a problem, but we chose not to include one for practical reasons. House staff commonly teach each other, so a control group would have been difficult to design. With a large house staff that rotates monthly, it is impossible to maintain a house staff control group unaffected by team intervention.

The medical regimen we proposed may be of particular interest to clinicians who treat large numbers of hospitalized asthmatics. In accord with recent studies,9,10 the treatment guidelines sought to continue the use of IV aminophylline, a goal that was achieved without apparent harmful effect. Oral theophylline use also declined. We attempted to limit the administration of IV corticosteroids to the first 24 h, and encouraged an early change to a single daily oral dose. The doses we recommend are in accord with published guidelines.11 Imperfect adherence to the guidelines reflects that some patients require a longer duration of therapy. Our guidelines encouraged the
house staff to exercise clinical judgment and to individualize therapy.

Administration of high-dose inhaled corticosteroids during a major asthma exacerbation is controversial. The Physician’s Desk Reference\(^{12}\) specifically states that their use is contraindicated, and the National Asthma Education Program report\(^{6}\) does not include these drugs as an option for hospitalized patients with asthma. However, others report the safe use of these agents,\(^{13}\) and triamcinolone administered with a spacer was uniformly well tolerated by our patients. The early use of high-dose inhaled corticosteroids has two potential advantages. It may permit very rapid reduction of systemic corticosteroid dose following discharge from the hospital.\(^{14}\) Inhaled corticosteroids are also likely to be an important component of the outpatient regimen, and their early introduction may improve outpatient adherence. The choice of the initial dose of triamcinolone (ten puffs bid), reflects the severity of the asthma, and should be reduced as tolerated on an outpatient basis to reduce the risk of systemic effects.

Our guideline suggests that β-agonist treatment should be self-administered as soon as tolerated. In addition to being cost-effective,\(^{15,16}\) educating each patient to use the MDI with spacer while still hospitalized develops a skill that he or she will require as an outpatient.\(^{17}\) We did not attempt to test the efficacy of any particular component of the medical regimen, but we found that the omission of IV aminophylline, early change to a single daily dose of prednisone, and early use of inhaled corticosteroids did not prolong hospitalization.

Most studies of treatment of asthma focus on one aspect of treatment. We combined many components, and therefore cannot comment on whether one may be more important than another. This study measured the improvement of the inpatient treatment process, rather than long-term outcome. Although inpatient care is part of a comprehensive asthma program, definitive impact on the disorder requires an effective outpatient effort.\(^{18,19}\) Our inpatient approach effectively identifies and educates patients with severe asthma, facilitating efficient referral to an outpatient program. Further research is needed to determine whether team intervention can decrease long-term asthma morbidity. This strategy is also labor-intensive and requires an ongoing commitment of personnel. Therefore, it would probably be cost-effective only in areas where severe asthma is prevalent.

We found the team approach comfortable and intuitively attractive. It permitted a systematic analysis of the patient care process, a measurement of improvement, and a mechanism for further improvement. As individuals, the team members had encountered difficulty in effecting change of a common clinical process within a large hospital. When the team focused its effort on analysis of delivering patient care and identified the changes needed in the process, our efforts were much more effective. We conclude that the team approach used in this study was effective in improving management of asthma in an inner-city hospital.

ACKNOWLEDGMENT: The authors thank Thomas Killip, MD, for his careful editing of the manuscript.

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