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Abstract: **Objective**. To estimate savings to health care system of a best-practice asthma intervention in primary care for inner-city children. **Methods**. Data were analyzed from National Heart, Lung and Blood Institute (NHLBI) Guidelines-based initial (n=244) and follow-up (n=202) asthma assessments of patients who received enhanced treatment in primary care. Savings were calculated using cost-of-illness model and compared with program cost. **Results**. Patients were about equally distributed between African American and Hispanic children (mean age = 7 years; range 36 months–19 years). Of those with persistent asthma, 36% had been prescribed a controller medication. This significantly improved on follow-up ($p<.01$). There were significant reductions in asthma severity ($p<.05$) and emergency department use ($p<.01$), and near-significant reduction in asthma hospitalizations ($p=.059$). **Conclusion**. Total annual savings attributable to clinical outcomes was $4,202,813 or $4,525 per patient with asthma. Total annual cost of the implementation was $390,169 or $420 per asthma patient. Conservatively estimated savings exceeded cost of intervention by nearly 11 to 1.

Key words: Asthma, child health, inner city, savings.

Asthma is one of the most commonly diagnosed chronic conditions of childhood in the United States. Federal data show a lifetime asthma prevalence (whether or not the child has ever been diagnosed with asthma) of 12.4%.[1] Inner-city asthma prevalence rates are higher than those reported in federal survey data.[2] This has been consistently demonstrated in studies in New York, Boston, and Chicago, where lifetime asthma prevalence rates from 30% and 35% have been found.[3,4,5,6,7]

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African American and Puerto Rican children have higher rates of asthma prevalence, hospitalization, and emergency department (ED) utilization than do non-Hispanic White children.[8] Inner city children with asthma are most likely to receive inadequate asthma management in primary care, leading to preventable ED visits and hospitalizations.[9,10,11,12]

In medically underserved inner-city communities, asthma has become the primary reason for pediatric ED visits and hospitalizations, and this is the case in New York City.[13] Administrative data from health maintenance organizations show that children who are non-White and poor have the highest asthma-related costs, driven in part by higher rates of ED use and of hospitalization

In this paper we describe an innovative program, The Children's Health Fund (CHF) Childhood Asthma Initiative, designed to reduce asthma among inner-city children. The Childhood Asthma Initiative was designed to integrate best practice asthma care protocols into pediatric primary care, beginning with CHF's New York City Program. We discuss asthma severity and morbidity in this population, present data to demonstrate the efficacy of this best-practice intervention, and calculate potential savings to the health care system associated with these clinical outcomes.

The CHF Childhood Asthma Initiative

Since 1987, CHF Child Health Projects, in collaboration with local teaching hospitals and community health centers, have provided continuous, comprehensive, coordinated, and culturally sensitive health care in a medical home model[14] to medically underserved children and families throughout the country. The Children's Health Fund has developed special initiatives to focus on conditions that disproportionately affect poor and low-income children, starting with asthma.

In 1991, the National Asthma Education and Prevention Panel (NAEPP) of the National Heart, Lung, and Blood Institute (NHLBI) issued best-practice guidelines for the diagnosis and management of asthma. The guidelines were revised in 1997 and again in 2004 and 2007. The 1997 revision emphasized classification of asthma severity through a formatted assessment of daytime and nocturnal symptoms, with a four-step classification: 1, mild intermittent; 2, mild persistent; 3, moderate persistent; and 4, severe persistent. Assessment of morbidity included interviewing parents/caregivers about the child's ED use, hospitalization, and missed school days for asthma.[15]

The Children's Health Fund implemented the Childhood Asthma Initiative shortly after the publication of the 1997 guideline revision in its New York Program, which serves homeless children in family shelters via mobile clinics and housed poor and low income families at its federally qualified health center in the South Bronx. The Children's Health Fund's New York Program is a service of Community Pediatrics, Children's Hospital at Montefiore.

Population Prevalence

The Childhood Asthma Initiative included population-based asthma surveillance using cross-sectional methodology and a validated screening tool based on the NHLBI

guidelines, and found lifetime asthma prevalence and/or current moderate-severe asthma symptoms among children entering the city's homeless family shelters to be the highest reported to date.[16] Over the 4½ year surveillance period, 16% of children presenting with moderate- or severe-persistent asthma symptoms had not previously been diagnosed.[17]

Based on retrospective chart review of a representative random sample of homeless patients seen during calendar year 2004, the asthma prevalence for homeless pediatric patients in the New York Program was 31.5%.[18] Asthma prevalence for pediatric patients of the South Bronx community health center, based on data from representative Bronx elementary schools, was 19.9%.[19]

Methods

Through the CHF Childhood Asthma Initiative all pediatric patients with asthma received guidelines-based treatment in the primary care setting. The intervention included staging of asthma severity based on parent recall of daytime and nocturnal symptom frequency (e.g., wheezing, cough, shortness of breath) with medication decisions guided by assessed severity. We recorded hospital and emergency department (ED) use for asthma based on parent recall. All asthma patients received health education at each asthma visit from the pediatrician. Appropriate medication use was a focus of this health education intervention.

A self-selected subset of patients participated in a standardized initial asthma assessment that included parent interview using a questionnaire we developed to include major data points in the 1997 NHLBI guidelines. Data were collected in a standardized way for symptom severity (daytime and nocturnal), hospital and ED use for asthma, missed school days for asthma, and medications. These data were coded and entered into SPSS for analysis. Where possible, we coded data into dichotomous variables. Data analysis was primarily descriptive, using frequencies and cross-tabs, with chi-square calculation of statistically significant differences.

We excluded patients younger than 36 months old on initial asthma assessment from data analysis to eliminate very young patients whose wheezing might not lead to a diagnosis of asthma.[20] Because there were no significant differences in initial or outcome data for the homeless or community health center populations, data from both clinical settings were combined for analysis. The initial assessment cohort comprised 244 consecutive initial assessments of patients with asthma, age 36 months or older (63% homeless, 37% community health center patients).

A self-selected subset of patients who had completed initial assessments returned for follow-up visits independent of acute need. While all patients who had a follow-up assessment had previously had an initial assessment, not all patients who had an initial assessment kept a subsequent appointment for a follow-up assessment.

Clinical follow-up data were analyzed for 202 consecutive follow-up assessments done for homeless patients and community health center patients (53% and 47% of the cohort, respectively). While items on the initial asthma assessment interview asked about ED and hospital use during the preceding 12 months, the corresponding items on the follow-up assessment focused on the preceding three months. We concluded that

clinical outcomes could be determined using three-month follow-up data after having tested these data to ensure that there was no bias due to seasonal variations in asthma severity and morbidity.[21] We tested these data through analyses based on the specific three-month interval in which the follow-up assessment was done (first, second, third or fourth quarter of the year) and on the specific month of the follow up visit. This allowed imputation of missing intervallic data points.[22,23]

While our data analysis focused only on patients who received standardized guidelines-based assessments, in practice we noted a "ripple effect" such that pediatricians who did not use the standardized forms with their asthma patients nonetheless incorporated the guidelines into their asthma treatment decisions.

Savings attributable to guidelines-based treatment in the primary care setting were calculated using a cost-of-illness model.[24] We excluded indirect costs often considered integral to a cost assessment of pediatric asthma (e.g., parents' missed days of work).[25]

Results

Initial assessments. Demographics: the mean patient age was seven years, range 36 months to 19 years. Fifty-two percent (52%) of the patients were African American and 48% were Hispanic.

About half of the asthma patients (49%) had moderate- or severe-persistent asthma at initial assessment. Two thirds (68%) had persistent asthma (severity step 2 or higher). Initial asthma severity assessed according to NHLBI guidelines is summarized in Table 1.

Nearly all (91%) of the patients had been prescribed a reliever medication (bronchodilator) by a community-based provider prior to becoming a patient. However, among patients with baseline severity in the persistent asthma range, only 36% had been prescribed an asthma control medication (e.g., inhaled corticosteroids). Forty-six percent of ED users had three or more visits; 9% had 10 or more, with a maximum of 25.

Clinical outcomes: follow-up assessments. The mean interval between initial and follow-up assessments was 6.5 months (range, 3 to 11 months). The mean age and age range were the same as for the initial assessment cohort. Fifty-two percent (52%) of the follow-up cohort was Hispanic and 48% was African American.

Table 1.

INITIAL ASTHMA SEVERITY IN THE POPULATION (N=244)

Step	Severity	Percent
1	Mild intermittent	32%
2	Mild persistent	19%
3	Moderate persistent	30%
4	Severe persistent	19%

On follow-up, asthma severity was significantly reduced ($p<.05$). Significantly more patients with persistent asthma based on initial assessment had been prescribed an asthma control medication (73% vs. 27%; $p<.01$). There was a significant reduction in proportion of patients using the ED for asthma (19.4% vs. 61.3%; $p<.01$) and a near-significant reduction in proportion of patients hospitalized for asthma (2.2% vs. 28.6%; $p=.059$). We reviewed primary care utilization for the patients in this follow-up cohort and determined that this decrease in ED use was not accompanied by a corresponding increase in primary care asthma visits (mean was constant at 1.8 asthma visits per year). Clinical outcome data are presented in Table 2.

Discussion

Our goal in assessing clinical outcomes was to compare initial assessments with annual assessments, by means of interview protocols, using a 12-month look-back for ED and hospital use. Annual assessments were very difficult to arrange because of the transient nature of the homeless population, and, in the community health center population, economic concerns that affected the ability of parents to take time off from work for an asthma follow-up appointment. Whether or not formal (i.e., standardized) assessments were done, however, improvements in asthma management were noted throughout the pediatric population because of the adoption of guidelines-based care practices by pediatricians whether or not they used the standardized assessment forms.

While children with asthma miss more school days than children who are not asthmatic miss, there is only a weak association between adequacy of asthma care and school attendance and academic achievement.[26,27] Many children with asthma attend school when acutely symptomatic, making on-site asthma care an important role of school-based health centers.[28,29] The child's symptom profile may be a more accurate reflection of the impact of asthma on readiness to learn and school performance.

The severity of asthma among patients with moderate- or severe-persistent asthma was primarily driven by nocturnal symptoms (79% of patients with moderate-severe nocturnal symptoms had mild daytime symptoms; $p<.01$). The most frequently occurring nocturnal symptom was frequent night cough that disturbs the child's sleep. This

Table 2.

CLINICAL OUTCOMES (N=202)

	Initial	Follow-Up
Persistent asthma, on a controller mediation	27%	73%
Hospitalization	28.6% of patients	2.2% of patients
Hospitalizations per user, mean	1.9	1.0
Emergency dept. (ED) visits	61.3% of patients	19.4% of patients
ED visits per user, mean	3.3	1.4

symptom is associated with sub-optimal academic performance and missed school days.[30] There was significant improvement in night cough on follow-up ($p<.05$), suggesting that the intervention had a positive impact at least on the child's readiness to learn in school.

These clinical improvements occurred during a period of city-wide decrease in pediatric asthma hospitalization and ED use as reported by the New York City Department of Health and Mental Hygiene (DOHMH). Despite years of improvement, however, the rate of pediatric asthma hospitalizations in poor and low-income neighborhoods city-wide was nearly three times that in more affluent neighborhoods during the time of our data collection. The City DOHMH attributed this disparity to a combination of higher asthma prevalence and inadequate control of asthma in poor and low-income communities.[31,32]

These continued disparities suggest that children in the city's low-income neighborhoods benefited least from improvements in primary care delivery such as evidence-based asthma management. The neighborhoods with the highest asthma rates reported by DOHMH included the South Bronx community in which the health center is located (Hunts Point–Mott Haven) and several communities of origin of the city's homeless families (East and Central Harlem in Manhattan and Central Brooklyn). These higher rates among poor children indicate that Medicaid is a major payor for these pediatric asthma hospitalizations.

Potential savings to the health care system. To calculate the potential savings to the health care system based on these clinical outcomes, we first determined the number of pediatric patients with asthma in the CHF New York Program based on patient population and prevalence rates for the homeless and community health center patient populations. We calculated the savings associated with the program's clinical success by subtracting the number of asthma ED visits and hospital admissions on follow-up from the baseline number and multiplying the difference by the unit cost.

The cost per ED visit was estimated at $500 with reference to the most current available Medical Expenditure Panel Survey (MEPS) data.[33] The cost per asthma hospitalization was derived from New York State Dept. of Health data.[34] The cost of pediatric asthma hospitalization varies by age category and by region within the state. We weighted the state's cost data according to the age distribution of the CHF New York Program population and adjusted for the cost differential between New York City and the rest of the state. This resulted in an estimated cost of $7,000 per asthma hospitalization.

Based on these calculations, the health care savings achieved by the Childhood Asthma Initiative was $4,202,813 per year (in 2004 dollars) for pediatric asthma patients of CHF's New York Program age 36 months through 19 years. This represents a savings of $4,525 per patient with asthma per year.

These savings must be assessed against the presumed cost of the CHF Childhood Asthma Initiative. This included the cost of additional clinical time spent at each asthma visit to assess asthma severity and engage the patient and parent/caregiver in asthma education to ensure that medications were administered appropriately and consistently. Cost was also incurred for newly prescribed asthma control medications, which were paid by government for publicly insured patients (Medicaid or State

Table 3.

TOTAL SAVINGS FROM CHF CHILDHOOD ASTHMA INITIATIVE INTERVENTION

A. Estimated # of asthma patients	# patients 3–19 yrs old in CHF (NY) Program	% asthma rate	# asthma patients
Homeless	1319	31.5	415.5
Housed	2579	19.9	513.2
Total			928.7
B. Change in hospital use	**% hospital users**	**mean # per user**	**# of admits**
Initial	28.6	1.9	504.7
Follow-up	2.2	1	20.4
Difference			484.2
Savings @ $7000 per use			$3,389,591
C. Change in Emergency Department (ED) use	**% ED users**	**mean # per user**	**# ED visits**
Initial	61.3	3.3	1878.7
Follow-up	19.4	1.4	252.2
Difference			1626.4
Savings @ $500 per use			$813,221
Total savings			$4,202,813

CHF = The Children's Health Fund

Children's Health Insurance Program [SCHIP]) and by the CHF New York Program for uninsured patients.

We established the cost of implementing the intervention by totaling the mean hourly physician salary and fringe benefits, and overhead as established in the CHF New York Program federal funding grant. This figure was multiplied by the amount of extra time spent in each asthma visit (15 minutes, based on clinical experience). This intervention cost was multiplied by the estimated number of patients with asthma age 3–19 years and by the mean number of asthma encounters per patient per year (1.8, based on chart review).

We then added the cost of newly prescribed asthma control medication based on the New York Program's pharmacy costs, resulting in a total program cost of $390,169 per year (in 2004 dollars) for the inclusion of NHLBI guidelines-based asthma care in a medical home model. Details of the savings and cost calculations are in Table 3 and Table 4.

Dividing the total program cost by the number of asthma patients 36 months to 19

years old, the cost per asthma patient per year was $420. The annual savings per asthma patient exceeded cost by a factor of 10.8 to 1. These savings do not include indirect savings from reduced parental missed work days or improved school attendance and academic outcomes, so this likely understates the full benefits from this program.

Conclusion

It has been suggested that the trend towards increased asthma prevalence may be due to improved and earlier diagnosis and differences in diagnostic criteria.[35] Our data strongly suggest that the 30% or greater lifetime asthma prevalence found among many inner-city pediatric populations reflects the degree to which asthma is under-diagnosed in these communities, and that inner-city asthma prevalence rates far exceed those found in federal survey data.

These urban, poor African American and Hispanic children often do not receive adequate asthma treatment to bring their symptoms under control, resulting in high and potentially preventable rates of ED use and hospitalization for asthma. The NHLBI guidelines present a framework for accurate asthma assessment and effective treatment. Integrating the guidelines into pediatric primary care will improve asthma outcomes and reduce preventable hospitalization and ED use.

Table 4.

COST OF CHF CHILDHOOD ASTHMA INITIATIVE INTERVENTION

A. Additional clinical time	
Additional visit time (hour)	0.25
Salary/hour ($2004)	$62.44
Fringe benefit rate	30%
Federal indirect rate	22.5%
Cost of additional clinical time/visit	$99.44
# Asthma patients age 3–19 years	928.7
Mean # visits per year per asthma patient	1.8
Total cost of additional clinical time	$41,557
B. Additional prescription meds	
# Patients with persistent asthma	631.5
Patients on asthma control meds at baseline	27%
Patients on asthma control meds at follow-up	73%
Patients with new asthma control meds Rx	46%
Cost of additional Rx asthma control meds per patient per year	$1,200
Total cost of additional prescription meds	$348,612
C. Cost of Program	$390,169

CHF = The Children's Health Fund

When children receive best-practice asthma care in a medical home model, the annual savings to the health care system exceeds $4,000 per child with asthma, based on conservative estimates. This savings is nearly 11 times the cost of integrating this best practice model into the primary care setting.

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