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CHILDREN WITH ASTHMA AT A MICHIGAN HOSPITAL EMERGENCY DEPARTMENT: DO THEIR CARE AND MANAGEMENT ADHERE TO THE NAEPP GUIDELINES FOR ASTHMA?

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By

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ABSTRACT

CHILDREN WITH ASTHMA AT A MICHIGAN HOSPITAL EMERGENCY DEPARTMENT: DO THEIR CARE AND MANAGEMENT ADHERE TO THE NAEPP GUIDELINES FOR ASTHMA?

By

Susan Rose Strahlendorf Bohm

In a single case cohort study of children with acute asthma at an emergency department, seven measures of their asthma care and management are compared with the NAEPP Guidelines. The relationship between symptom-based chronic severity and asthma outcomes are examined. Parents of 139 children 2–17 years with acute asthma were interviewed at an urban Michigan emergency department and at two weeks after discharge. The mean age of the children was 8.4±0.7 years, 47% had health insurance through Medicaid, and 95% had a primary care provider. The chronic severity of 48% of the cohort was classified as mild intermittent. Of seven recommendations, only the use of inhaled corticosteroids and a consultation with an asthma specialist in the past year showed a statistically significant relationship with severity. An estimated 19% of patients with moderate to severe persistent asthma were not taking any long-acting control medication. No correlation was found between chronic and acute severity. Gaps in adherence to the NAEPP Guidelines are not related to barriers to access to care but may lie in patient lack of knowledge of or inability to follow an asthma management program.

To my husband, Fredric, and my daughter, Kirsten April

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Chapter 1

Introduction

The burden of asthma in children in the U.S. and elsewhere has increased dramatically in the past two decades, whether measured by national health surveys or utilization rates of hospital services for treatment of asthma (Akinbami and Schoendorf 2002; Beasley 2002). Concern over rising asthma morbidity and mortality was the impetus for the formation of the National Asthma Education and Prevention Program (NAEPP) in 1989 by the United States National Heart, Lung, and Blood Institute (NHLBI) with the intention of improving asthma management through the establishment of national guidelines and recommendations for asthma care and treatment. While these guidelines have been available since 1981, there has been little focus on whether treatment and care provided to children with asthma is consistent with the NAEPP Guidelines. This thesis will examine the level of adherence to a number of key NAEPP recommendations regarding asthma care and management in a cohort of children who visited a Michigan hospital emergency department for the treatment of asthma.

Definition of asthma

Asthma is a chronic disease affecting the lungs and the airways that deliver air to the lungs. Asthma is defined by recurring episodes of wheezing, coughing, shortness of breath, sensation of tightness in the chest, and reversible reduction in peak expiratory flow, as a result of acute or chronic inflammation of the airways. Decreases in forced expiratory volume during the first second of an exhalation (FEV1) or increased variability in peak expiratory flow (PEF) are indicative of asthma. Airway obstruction is

considered reversible when the FEV1 improves by 20% or more after the inhalation of a bronchodilator (e.g., a short-acting β2-agonist) (Beers and Berkow 1999). Although asthma can be controlled with medication and by avoiding asthma triggers, there is no known cure. Common asthma triggers include allergies (e.g., pet dander, dustmites, cockroaches, mold, pollen), dust, weather changes, exercise, and irritants such as air pollution, cigarette smoke, and chemical and fuel vapors (Institute of Medicine 2000).

Clinical presentation of asthma

An individual presenting with asthma exhibits difficulty breathing. The patient assumes an upright posture when struggling for breath. Use of the accessory respiratory muscles is evident. Wheezing can be heard throughout inspiration and expiration, which is sometimes accompanied by coarse rattling. The chest may appear hyperinflated or overexpanded. Rapid respiration and heart rate are present. In a severe attack, breathing will be so compromised that the patient may only be able to say a few words at a time. Mental confusion, lethargy, and fatigue set in with severe respiratory distress. As the attack worsens, cyanosis can be observed. In progressive respiratory failure, less wheezing may be heard, owing to advanced mucous plugging and a marked decline in airflow and gas exchange. The severity of asthma can be assessed clinically by measuring the arterial blood gases.

Even when patients seem asymptomatic between asthma attacks, they may still exhibit low to moderate wheezing. In persons with severe long-term asthma, physical changes in the chest wall, such as a 'squared off' thorax, a bowing of the sternum, or a depressed diaphragm may occasionally be evident.

Classifying asthma severity

The 1997 *NAEPP Guidelines* provide a classification scheme for assessing asthma severity and advocate appropriate asthma treatment and management that corresponds with the patient's level of severity (NAEPP 1997). Asthma is classified into four levels: mild intermittent, mild persistent, moderate persistent, and severe persistent asthma. Four criteria are used to categorize the asthma severity of patients: daytime symptoms, night-time symptoms, frequency by which exacerbations affect activities, and PEF or FEV1 measurements. Patients are classified according to the symptom with the highest level of severity (see Table 1).

Table 1. The 1997 NAEPP classification of asthma severity

Level of severity	Daytime symptoms	Night-time symptoms	PEF or FEV1	PEF variability
Mild intermittent	≤2/week (Exacerbations brief)	≤2/month	≥80%	<20%
Mild persistent	3–6/week (Exacerbations may affect activity)	3–4/month	≥80%	20–30%
Moderate persistent	Daily (Exacerbations affect activity; ≥2 times /week)	≥5/month	>60–<80%	>30%
Severe persistent	Continual (Exacerbations frequent)	Frequent	≤60%	>30%

Note: Clinical features before treatment. From (NAEPP 1997).

Acute asthma, often called an exacerbation, is characterized by a worsening of asthma with increased symptoms (as shown in Table 1) and reduced lung function. Although asthma symptoms can often progress over time to acute asthma, it is not uncommon for people with a history of intermittent asthma to develop severe asthma symptoms necessitating a visit to the emergency department.

Pathophysiology of asthma

A longstanding theory suggests that people with asthma have hyperreactive airways that are more sensitive than normal to irritation (Pearce et al. 1998). An asthma attack occurs when the lining of the bronchial tube is irritated by an external trigger, becomes inflamed and, in response, bronchoconstriction occurs (Fig. 1).

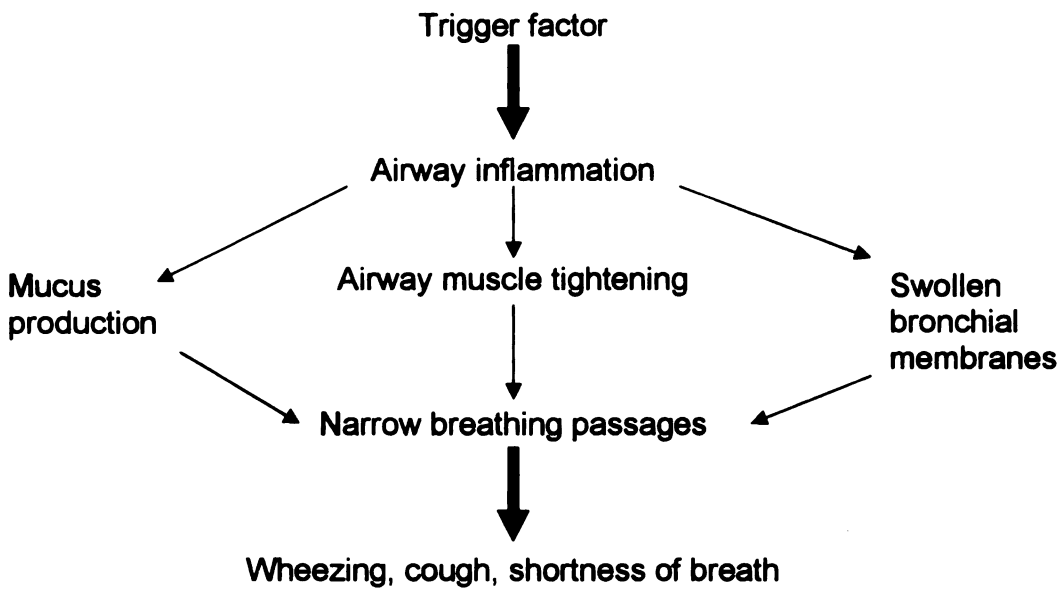

Fig. 1. Pathway to asthma. Adapted from Protocare Corp. (1997).

It is this bronchoconstriction, accompanied by mucus secretion and edema, which provokes the common symptoms of asthma: coughing, wheezing, labored breathing or dyspnea, and chest tightness (American Medical Association 2002).

The underlying disease mechanism of asthma thus involves two components: bronchoconstriction and airway inflammation. Numerous immune cells, such as mast cells, eosinophils, neutrophils, macrophages, T lymphocytes, and cytokines and chemokines released by airway epithelial cells engage in complex interactions during

an inflammatory response. In chronic asthma, these interactions can lead to structural changes or remodeling of the lungs resulting in permanent changes in lung function (AMA 2002).

To address the two underlying components of asthma, inflammation and bronchoconstriction, current asthma pharmacotherapy includes anti-inflammatory and bronchodilator medications (AMA 2002).

Growing asthma prevalence in US and Michigan

Prevalence of asthma in the U.S. among both adults and children ranks among the highest in the world (ISAAC 1998; Beasley 2002). Obtaining a valid estimate of the prevalence of asthma is difficult, owing to different methods of asthma ascertainment, changes in diagnosis, and methods of data collection (e.g., survey instruments) over time. One of the principal sources of asthma prevalence data for the United States has been the National Health Interview Survey (NHIS), a household survey of a representative sample of the noninstitutionalized civilian U.S. population (CDC 2000). Prior to 1997, information on asthma was obtained in the NHIS survey by asking, "During the past 12 months, did anyone in the family have asthma?" The self-reported 12-month prevalence of asthma in the U.S. in 1996 was 55/1000 people, an increase of almost 74% since 1980 (Mannino et al. 2002).

In 1997, asthma prevalence questions in the NHIS survey were restricted to persons medically diagnosed with asthma and who had experienced an asthma attack in the last year. The resulting asthma attack prevalence was 40.7/1000 people. From 1997 to 1999, the number of episodes of asthma in the preceding year in fact dropped 5.6% (National Center for Health Statistics 2001; Mannino et

al. 2002); however, it is not certain whether this is indicative of a true trend or a reflection of the change in the definition of asthma.

The Behavioral Risk Factor Surveillance System (BRFSS), a national telephone survey in the U.S. of risk factors for chronic disease and health conditions in adults (≥18 years), has recently added questions about asthma prevalence to its core questionnaire. In 2000, the overall prevalence estimate for adult Americans with self-reported lifetime asthma ('Have you ever been told by a doctor that you have asthma?') was 10.5%; that of current asthma was 7.2% ('Do you still have asthma?'), with much variation across states (CDC 2001). Lifetime asthma prevalence ranged from 8.0% in Louisiana and South Dakota to 13.4% in Nevada and 15.9% in Puerto Rico; the prevalence of current asthma ranged from a low of 5.0% in Louisiana to a high of 8.9% in Maine (CDC 2001). Lifetime asthma prevalence and current asthma prevalence in Michigan closely mirrored the national figures (10.3% and 7.3%, respectively).

Based on NHIS data, prevalence of asthma among American children aged 5–14 years increased 74%, rising from an average of 42.8 per 1000 in 1980 to 74.4 per 1000 in 1993–1994 (NHLBI 1999). An even more dramatic increase over this time period was seen in children under the age of 5 years: 160% from 22.2 per 1000 to 57.8 per 1000. Apart from the self-reported BRFSS data, prevalence data do not exist at the state or county level. Weiss et al. estimated regional prevalence rates that were calculated from multi-year averages of asthma prevalence from the 1993–1995 National Health Interview Survey data sets (Weiss et al. 2000). People with asthma were defined as having asthma in

the past year, and proxies were used for children under 19 years of age. Asthma prevalence estimates were then calculated for 42 combinations of age, gender, and race. Using county population estimates (by race, gender and age group) from the 1994 U.S. census, local asthma prevalence rates were computed and applied to the 42 demographic groups (Weiss et al. 2000). Because prevalence rates were derived from national demographic groups, these estimates may not reflect regional differences, e.g., asthma prevalence may be underestimated for counties with large low-income inner-city populations. Weiss' prevalence estimates for the State of Michigan and Kent county are presented in Table 2.

Table 2. Regional prevalence estimates from 1993–1995 (NHIS)

Region	Estimated prevalence (per 100 population)	Number of people with asthma
Michigan (all)	5.49	521,200
≤17 years	7.36	185,400
≥18 years	4.81	335,900
Kent County (all)	5.50	28,600
≤17 years	7.21	10,700
≥18 years	4.82	17,900

Note: From Weiss et al. (2000). See text re how data were calculated.

In 2001 the Behavioral Risk Factor Survey in Michigan asked two questions about asthma in children in the household, "Earlier you said there were ___ children age 17 or younger living in your household. How many of these children have ever been diagnosed with asthma?" The prevalence estimate of children in Michigan ever diagnosed with asthma was 12.2±1.8%, and of children who still have asthma, 8.3±1.4% (S. Bohm, MDCH, Nov 15, 2002).

Utilization of health services for asthma

Hospitalizations for asthma

Measures of asthma morbidity include self-reported prevalence (as previously discussed), hospitalizations and emergency department visits for asthma attacks, and physician office visits. The estimated annual rate of hospitalizations for asthma in the U.S. peaked in 1985 (19.7/10,000 population) and has since been on the decline (Mannino et al. 2002). Data from the 2000 National Hospital Ambulatory Medical Care Survey give a hospitalization rate for asthma of 17/10,000 (NCHS 2003).

From Michigan hospital inpatient discharge data for the period 1992–1993, asthma accounted for 9.4% of all hospitalizations in children under the age of 15 years, and 13.3% of all hospitalizations in children aged 5–9 years. (Wilcox and Hogan 1996) For Kent County, the annualized hospitalization rate for children during 1989–1993 was 21.4/10,000, which is much lower than the overall state rate of 34.3/10,000. By comparison, southeastern Michigan (counties Wayne, Washtenaw, Jackson and Lenawee) had the highest hospitalization rate of 53.1/10,000 (Wilcox and Hogan 1996). This may be explained by the fact that these counties have a higher proportion of minorities than Kent County. From 1989 to 1993, the annualized hospitalization rate for black children in Michigan was 3.2 times higher than that for white children (blacks, 81.3/10,000 vs. whites, 25.6/10,000) (Wilcox and Hogan 1996). More recent data regarding hospitalization rates for asthma by gender, given in Table 3, show that Kent and Ottawa County rates for both genders remain below those for Michigan.

Table 3. Michigan hospitalization rates by gender, 1990–1997

Region	Hospitalized for Asthma (1990–1997) per 10,000 children ages 1–14	
	Males	Females
Michigan	38	22
Kent County	27	14
Ottawa County	15	9

Note: Data from Primary Health Care Profile of Michigan (Michigan Primary Care Association 2002).

ED visits for asthma

Asthma is one of the most common reasons for pediatric patients to visit an emergency department (Dawod et al. 1996; Zimmerman et al. 1998). In the U.S., the number of emergency department (ED) visits for asthma from 1992 to 1999 (data collected by the National Hospital Ambulatory Medical Care Survey) increased 36% (Mannino et al. 2002). The annual rate for ED visits rose 29%, from 56.8 in 1992 to 73.3 per 10,000 people in 1999. Over this same period, females had consistently higher rates than males. Among children, those aged 0–4 years had the highest rate of ED visits: 141.8/10,000 in 1999. Blacks had substantially higher rates than whites (1999 figures: 174.3 vs. 59.4 per 10,000, respectively) (Mannino et al. 2002).

Data recently released from the 2000 National Hospital Ambulatory Medical Care Survey show the rate of ED visits for asthma as 67/10,000 population, a decline of 8.6% from 1999 (NCHS 2003) (Fig. 2). In 2000, children under 18 had an ED visit rate of 104/10,000. ED visit rates for children 0–4 years were high at 180/10,000. Although that for blacks was 125% higher than whites, the ED visit rate had dropped to 133/10,000 from 1999. The rate for whites remained unchanged, and that for women was almost 30% higher than for males (NCHS 2003). Applying the 2000 national ED visit figure for

children under 18 to the combined 2001 population estimates for Kent and Ottawa counties gives an annual estimate of approximately 2400 ED visits for asthma.

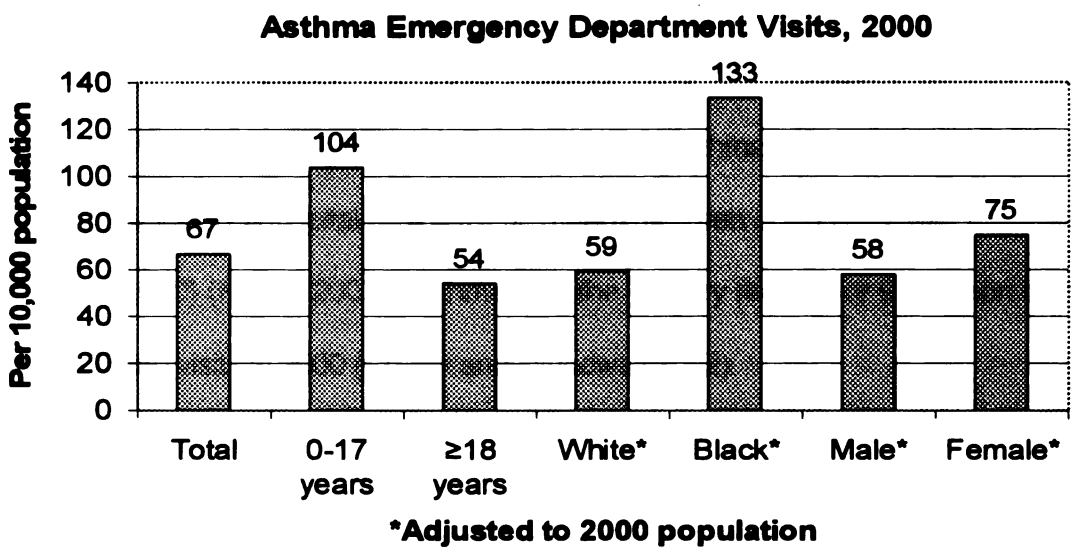

Fig. 2. Asthma emergency department visits, 2000 (NCHS 2003).

The recent decline in some hospitalization and ED visit rates may be an indication that some progress towards reducing the health burden of asthma is being realized, perhaps stemming from the integration of the asthma care NAEPP guidelines of the National Health Lung and Blood Institute into asthma education interventions and asthma management plans designed for patients (Mannino et al.2002).

Office and outpatient visits for asthma

Another indicator of the health burden of asthma is the number of physician office and hospital outpatient visits. Data on physician office visits were collected through the National Ambulatory Medical Care Survey from approximately 2000 participating physicians. The National Hospital Ambulatory Medical Care Survey was the source for data on hospital outpatient visits; this survey samples roughly 500 hospitals annually.

From 1980 to 1999 in the U.S., the number of physician office visits for asthma increased from 5.9 to 10.8 million. It should be noted that from 1992 to 1999, hospital outpatient visits (approximately 1 million annually) were included with physician office visits (Mannino et al. 2002). The 2000 National Hospital Ambulatory Medical Care Survey reported 10.4 million outpatient visits for asthma were made to private physicians offices and hospital clinics (379/10,000); children aged 0–17 had 4.6 million visits (649/10,000) (NCHS 2003). Asthma was the primary reason for 9.3 million office-based physician visits in 2000 (Cherry and Woodwell 2002).

Clinical practice guidelines

Clinical practice guidelines are developed, primarily by health organizations, to assist practitioners and clinicians in making clinical decisions (Homer 1997). Ideally, guidelines provide useful advice on a range of topics, such as evaluating medical conditions, assessing risk, or proposing appropriate health interventions and follow-up care. By defining current best practice and providing up-to-date treatment information, clinical guidelines are intended to reduce inappropriate health care, costs, and malpractice suits, while optimizing health outcomes (Woolf 1993). A 'mechanism of action,' proposed by Woolf (1993), describes in stepwise fashion the process through which guidelines become adopted into practical use. Guidelines that are effectively assimilated into practice, first, must improve knowledge by increasing physicians' awareness of the recommendations; second, must gain agreement and acceptance in the medical community; third, must be implemented by changing physicians' practice

behavior to be in line with the recommendations; and fourth, must improve health- and (or) cost-related outcomes (Woolf 1993).

There has been, however, little direct evidence that practice guidelines actually improve clinical outcomes in primary care or change physician behavior (Lomas et al. 1989; Worrall et al. 1997; Cabana et al. 1999). Criticism of guidelines has often centered on the validity of the underpinning evidence for the recommendations. The basis for recommendations in the past has ranged from strong evidence coming from rigorous randomized clinical trials to weak evidence from observational studies or from expert opinion in absence of any real data (Wilson et al. 1995; Worrall et al. 1997). Development of guidelines has evolved from reliance on consensus and expert opinion toward evidence-based data, as these studies have become available (Hayward et al. 1995; Wilson et al. 1995; Worrall et al. 1997). Thus, implementation of the more recent evidence-based guidelines may in fact lead to improved patient outcomes (Worrall et al. 1997).

Guidelines for the Diagnosis and Management of Asthma

The *1991 Expert Panel Report: Guidelines for the Diagnosis and Management of Asthma* was published by the NAEPP to provide information on the diagnosis and management of asthma backed by scientific research available at the time. The *1991 Guidelines* comprised four components of asthma management: measures of assessment and monitoring, control of factors that contribute to asthma severity, pharmacologic therapy, and education in asthma care for both health professionals and patients. Six years later the *Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma* was issued to provide

an update to the 1991 recommendations. Updates included expansion of the role of inflammation in asthma, changes in the classification of asthma severity, and changes in recommendations for monitoring and pharmacologic treatment of asthma based on firmer scientific evidence. One of the most notable improvements of the 1997 Guidelines over those issued in 1991 has been the increased scientific base of asthma research for the recommendations (NAEPP 1997).

As primary care physicians see about three-quarters of all asthma visits by children, the promotion of the *NAEPP Guidelines* was directed at the primary care community (Fried 1998; Grant et al. 1999). Two studies examined the adherence of primary care physicians to components of the *NAEPP Guidelines* (Grant et al. 1999; Finkelstein et al. 2000). In 1998 the Finkelstein study surveyed 671 primary care pediatricians and family physicians, who practiced in three managed care organizations located in Chicago, Seattle, and Boston. The cross-sectional study by Grant et al. mailed questionnaires to 405 Chicago-area physicians identified by the American Medical Association database. The Grant study was conducted in 1997 and overlaps with the issuance of the *1997 Guidelines* (Grant et al. 1999). Awareness of the *NAEPP Guidelines* was high: 88.5–91% of physicians in both surveys had heard of the *Guidelines* and 72–73.6% had read them. Although physicians demonstrated awareness of the recommendations, there were still gaps in the physicians' promotion of self-management practices, e.g., providing written asthma treatment plans ranged from 47.7 to 50%. Only 23.6% of physicians in the Grant survey reported that they referred patients to formal asthma education, although all physicians indicated that they provided some form of patient education.

Failure to integrate the *Guidelines* into practice does not appear to be due to lack of awareness. However, reasons cited for noncompliance by physicians include barriers in adopting the practices (lack of time, recommendations not convenient to use), disagreement with the *Guidelines,* and belief that the recommendations are too rigid for patients (Hayward et al. 1997; Picken et al. 1998; Cabana et al. 1999). Lack of educational materials, support staff, and reimbursement were cited as additional reasons for physician noncompliance with the asthma recommendations in another national survey of 829 physicians (Cabana et al. 2001).

The *NAEPP Guidelines* set out six goals for maintaining control of asthma for adults and children older than 5 years of age: (1) prevent chronic and troublesome symptoms, such as coughing or breathlessness in the night, in the early morning, or after exertion, (2) maintain (near) normal pulmonary function, (3) maintain normal activity levels (including exercise and other physical activities), (4) prevent recurrent exacerbations of asthma and minimize the need for emergency department visits or hospitalizations, (5) provide optimal pharmacotherapy with minimal or no adverse effects, and (6) meet patients' and families' expectations of and satisfaction with asthma care (NAEPP 1997).

Several NAEPP recommendations for the care and home management of asthma are aimed at achieving these goals: (1) regularly scheduled appointments with asthma care providers, (2) self-monitoring of peak expiratory flow (PEF), (3) appropriate pharmacologic therapy, (4) written asthma management and action plan, (5) asthma education, (6) referral to an asthma specialist when asthma is difficult to control, and (7) follow-up visits with a primary care doctor within 5 days after a visit to the emergency department for asthma.

(1) Scheduled appointments with the patient's regular asthma care provider

The guidelines recommend regularly scheduled visits to the regular asthma care provider (RACP) at 1- to 6-month intervals to ensure that the patient's asthma is under control (NAEPP 1997). The RACP is defined as the health professional responsible for writing the patient's prescriptions; developing the asthma management and action plans; providing counseling, on-going treatment, and asthma education; and monitoring the disease. Patients with mild intermittent and mild persistent asthma that has been under control for at least 3 months should be seen by their RACP every 6 months. Those with persistent asthma are advised to have asthma check-ups more frequently. As part of a routine asthma checkup, the RACP assesses a patient's asthma, reviews the patient's asthma self-management and action plan, and asks about difficulties the patient may be encountering with respect to peak flow monitoring, inhaler technique, or drug side effects (NAEPP 1997).

(2) Peak expiratory flow monitoring

Peak expiratory flow (PEF) monitoring is a recommended practice for those with moderate to severe asthma. A fundamental part of a patient's asthma self-management toolkit, PEF monitoring measures the existence and severity of an airway obstruction. Patients must first establish a personal best value, which is the highest peak expiratory flow rate (PEFR) recorded, by taking measurements twice daily over a 2- to 3-week period (Stritch School of Medicine 2002). The personal best PEF differs from the predicted value, which is an average PEFR value based on gender, age, and height (Stritch School of Medicine 2002). A patient's PEF readings may be higher or lower than their predicted value. By observing trends in PEF readings, adjustments can be

made to the patient's treatment plan to return the readings to the personal best value (Stritch School of Medicine 2002). Generally, children over the age of 5 are capable of using a peak flow meter with proper training. For all persons with asthma, taking peak flow readings during an exacerbation can assist in controlling the symptoms, however, because of noncompliance concerns, the *Guidelines* do not recommend long-term peak flow monitoring for patients with mild intermittent or mild persistent asthma.

(3) Pharmacotherapy

The *1997 Guidelines* also address the assignment of appropriate medications to control each level of severity. For adults and children of all ages, no long-term control medication is recommended for mild intermittent asthma. For mild persistent asthma, daily anti-inflammatory medication is recommended for long-term control in the form of an inhaled low dose steroid, or cromolyn or nedocromil for children older than 5 years. Medications for long-term control of moderate persistent asthma include either a medium dose of inhaled corticosteroid or a low to medium dose of inhaled corticosteroid plus, if needed, a long-acting bronchodilator (β-agonist, theophylline, or leukotriene modifier). For severe asthma, a high dose inhaled corticosteroid plus a long-acting β-agonist (LABA) is the preferred treatment. A stepwise approach to pharmacotherapy is endorsed by the NAEPP: therapy should commence at a level higher than the patient's current stage of severity to gain control swiftly and then treatment may be stepped down to the point at which the minimum dose of medication is sufficient to maintain control. Treating asthma more aggressively initially brings about more rapid suppression of airway inflammation. The stepwise approach coincides with the four

severity levels: step 1, mild intermittent asthma; step 2, mild persistent; step 3, moderate persistent; and step 4, severe persistent.

An update of the *Guidelines* issued in July 2002 focused on the importance of inhaled corticosteroids in controlling asthma (NAEPP 2002). Inhaled corticosteroids as a first-line therapy for children as well as for adults with persistent asthma is now an NAEPP recommendation backed by strong evidence from nine randomized trials. The preferred treatment for moderate persistent asthma for adults and children over 5 years of age was revised to include LABA as adjunct therapy with low to medium dose inhaled corticosteroids. The update included specific treatment modifications at each step. The preferred long-term control treatments are as shown in the table below; quick relief medications can be used as needed by all patients.

Table 4. July 2002 NAEPP Guideline updates on preferred long-term control medications

Level of severity	**Daily medications recommended**
Step 4 Severe persistent	High-dose inhaled corticosteroids And Long-acting inhaled β-agonists And, if needed, Corticosteroid tablets or syrup (systemic)
Step 3 Moderate persistent	Low- to medium-dose inhaled corticosteroids And Long-acting inhaled β-agonists
Step 2 Mild persistent	Low-dose inhaled corticosteroids
Step 1 Mild intermittent	No daily medication needed. Systemic corticosteroids are recommended when severe exacerbations occur

(4) Asthma management plan

To control and adequately manage asthma, a patient must adhere to a multifaceted asthma management program, developed with the RACP. An asthma management plan covers appropriate use of medication tailored to the patient's level of severity, regular checkups, prevention by avoiding or controlling known asthma triggers, and an asthma action plan (Leickly et al. 1998). The asthma management plan also includes personal goals the patient wishes to attain, such as being able to manage their symptoms to the point that they can, for example, play sports without succumbing to an asthma attack. When a patient experiences an asthma exacerbation, the individual has lost control of his/her asthma, signaling the need to review and adjust the asthma management program.

An individualized asthma action plan informs the patient what steps to follow when their asthma worsens (NAEPP 1997). These instructions advise the patient to adjust their asthma medications in response to signs and symptoms they are experiencing and to their peak flow measurements. An action plan also lists local acute care and emergency telephone numbers, and any other special instructions to assist a patient during an exacerbation.

(5) Asthma education

The *NAEPP Guidelines* recommend that at or shortly after the time of diagnosis, the primary health care provider should provide essential asthma education, including basic information about the disease and what happens to the airways during an exacerbation; how long-term and quick relief medications work and the differences between them; techniques for using asthma equipment such as inhalers, spacers, and peak flow

meters; identifying environmental asthma triggers and how to avoid them; and how to recognize worsening asthma symptoms and the appropriate actions to take (NAEPP 1997). These educational messages need to be reviewed periodically with the patient.

(6) Consultation with an asthma specialist

Seeing an asthma specialist, usually an allergist or a pulmonologist, is recommended for patients who encounter difficulties in controlling their asthma. This recommendation is based on the opinion of the NAEPP Expert Panel, in absence of evidence-based data. If the patient has had a life-threatening exacerbation or requires intense treatment for moderate to severe persistent asthma (step 3 and 4 care), if there are comorbidities or allergy problems that complicate the treatment of asthma, or if the patient is on a continuous regimen of oral or high-dosed inhaled corticosteroids, a consultation with an asthma specialist may provide additional therapies, education, or insight in dealing with an environmental exposure.

(7) Follow-up appointment after an ED visit

After an exacerbation that requires hospitalization or an emergency department visit, the *Guidelines* advocate a follow-up medical appointment with the RACP within 5 days after discharge to establish or resume regular asthma care and to review the patient's medications, asthma action plan, and techniques in using their asthma equipment.

Systematic review of studies of children attending emergency departments for treatment of asthma

Emergency departments (EDs) provide a unique opportunity to collect asthma data directly from patients. Numerous studies using Medicaid or managed care databases have been conducted on aspects of primary asthma care and management, health care utilization, and

various asthma-related outcomes, but the data are usually limited to the information available on the health insurance records. Disadvantages of studies based on chart abstraction from health insurance companies include exclusion of children without health insurance, the inability to directly assess chronic asthma severity based on frequency of symptoms or by peak flow measurements (as per the NAEPP), and lack of information regarding actual or current use of asthma medications and asthma equipment such as peak flow meters (Barnett and Oberklaid 1991; Finkelstein et al. 2000; Apter et al. 2001; Shields et al. 2002). Interviews with patients in emergency departments can provide more comprehensive information on symptoms of chronic underlying severity; how patients manage their disease in terms of monitoring symptoms and taking medication, and what asthma education they have received.

A literature search for articles assessing primary asthma care and management of ED pediatric patients and comparison with the NAEPP recommendations was conducted using Medline. Keywords "National Asthma Education and Prevention Program, *NAEPP guidelines*, National Heart, Lung, and Blood Institute (NHLBI) guidelines, children, asthma, emergency" yielded a total of 125 articles from 1991 to January 1, 2003. Nine articles were selected that fit the criteria of cohort or cross-sectional surveys of ED visits by children for asthma treatment, and that collected data on any of seven key measures of asthma care and management from the NAEPP recommendations (as previously listed). Bibliographies of studies comparing patient asthma care and management characteristics with the *NAEPP Guidelines* were also checked for additional references. Although three of the nine reviewed articles made no mention of the *Guidelines*, their data contained measures that could be compared with

the seven recommendations (Butz et al. 1991; Friday et al. 1997; Ferris et al. 2001). Three articles cited the NAEPP recommendations (Davidson et al. 1994; Farber et al. 1998; Stevens and Gorelick 2001) and three papers made direct comparison of several measures with the *Guidelines* (Crain et al. 1998; Dinkevich et al. 1998; Scarfone et al. 2001).

Emergency department use for asthma care has been associated with younger children, lower income, living in an urban center, minority status, and poorer health (Halfon and Newacheck 1993; Halfon et al. 1996; Hanania et al. 1997; Zimmerman et al. 1998; Woodward et al. 1988). Six of the nine ED studies took place at inner city hospitals (Butz et al. 1991; Friday et al. 1997; Dinkevich et al. 1997; Farber et al. 1998; Crain et al. 1998; Stevens and Gorelick 2001). Inner cities have been shown to have higher proportions of asthma and non-Caucasian populations who are more likely to receive episodic rather than continuous medical care and to receive that care in emergency departments (Weiss et al. 1992; Halfon and Newacheck 1993; Crain et al. 1994; Halfon et al. 1996). The remaining studies were carried out in urban hospitals (Davidson et al. 1994; Ferris et al. 2001; Scarfone et al. 2001). Two surveys enrolled patients aged 18 and under (Friday et al. 1997; Dinkevich et al. 1998), while the other studies restricted eligibility to children aged 2–17 years (Davidson et al. 1994; Ferris et al. 2001), 2–18 years (Scarfone et al. 2001; Stevens and Gorelick 2001), 7–12 years (Butz et al. 1991), 4–9 years (Crain et al. 1998), and 2–6 years (Farber et al. 1998). In five studies, children with Medicaid health coverage constituted 50% or more of the study population (Davidson et al. 1994; Crain et al. 1998; Dinkevich et al. 1998;

Scarfone et al. 2001; Stevens and Gorelick 2001). See Table 5 for study design and patient demographics.

Eligibility for participation in the studies was based on a case definition of asthma that ranged from presentation with wheezing symptoms (Friday et al. 1997; Dinkevich et al. 1998), presentation of acute asthma symptoms (Butz et al. 1991; Davidson et al. 1994; Ferris et al. 2001), to a previous physician diagnosis of asthma, history of asthma, and use of bronchodilators (Farber et al. 1998; Stevens and Gorelick 2001).

The NAEPP reclassified asthma severity in the *1997 Guidelines* from mild, moderate, and severe, as given in the *1991 Guidelines,* to mild intermittent, and mild, moderate, and severe persistent. Severity of asthma was documented in only four studies (Crain et al. 1998; Dinkevich et al. 1998; Farber et al. 1998; Scarfone et al. 2001). Assessment of asthma severity differed among the four studies. Scarfone reported that 64% had persistent chronic asthma interpreting the *NAEPP Guidelines* on severity (based on frequency of day- and night-time symptoms), while 72% in the Farber study had moderate to severe asthma. The Farber study used the Asthma Functional Severity Scale to determine severity. Briefly, this measurement of severity is based on frequency and intensity of asthma episodes, and the frequency of symptoms and intensity of impairment between episodes over the previous year (Rosier et al. 1994). Two categories of severity were reported in the Dinkevich study: 54.6% were calculated to have had fewer than four attacks in the past year and 44.8% had four or more attacks. Children with more than four attacks also reported worse functional morbidity (measured by frequency of day- and night-time cough and of nights of poor sleep) (Dinkevich et al. 1998). The NAEPP classification of asthma severity is symptom based,

Table 5. Review of ED studies

Author, study	n	Case def'n	Age, years	Site	Insurance	Race, ethnicity
Butz et al. 1991 Prospective cohort	155	Acute asthma	7–12	Baltimore, MD Inner city pediatric ED	NA	92% African American (AA)
Davidson et al. 1994 Survey	170	Asthma symptoms	2–17	Providence, RI Urban ped ED	52% Medicaid (MA) 3% none	24% AA 18% Hispanic
Friday et al. 1997 Pros. survey	1474	Wheezing	66% <5 years	Pittsburgh, PA Inner city ED	48.7% MA 12.6% none	54% AA
Dinkevich et al. 1998 Survey	398	Wheezing	<18	Bronx, NY Inner city ED	75% MA 13.7% none	30.6% AA 61% Hispanic
Farber et al. 1998 Survey	46	Asthma, bronchodil. Tx in ED	2–6	New Orleans, LA Inner city ped ED	NA	100% AA
Crain et al. 1998 Survey	1376	≥2 asthma meds or ≥2 ED visits or hospitalized	4–9	13 US EDs & 25 primary care centers	74% MA 75 none	74% AA 20% Hispanic
Ferris et al. 2001 Pros survey	1184	Acute asthma	2–17	US urban medical centers	37% MA 17% none	54–66% AA 13–32% Hispanic
Stevens et al. 2001 Pros. cohort	388	Asthma or ≥2 attacks Tx with B-agonists	2–18	Philadelphia, PA Inner city ped ED	72% MA 5% none	92% AA
Scarfone et al. 2001 Survey	433	Acute asthma	2–18	Philadelphia, PA Urban ped ED	57% MA 13% none	93% AA

whereas many studies categorize severity on criteria such as frequency of use of health services for urgent treatment. In the Crain study, 50% of the patients were intentionally selected with severe asthma, based on reporting the following criteria in the previous year: used two or more asthma medications simultaneously, or were hospitalized, or had had two or more ED visits.

Access to primary care providers (PCPs) was generally high. In six articles that reported this information, over 90% of the patients had a PCP (Davidson et al. 1994; Crain et al. 1998; Dinkevich et al. 1998; Ferris et al. 2001; Scarfone et al. 2001; Stevens and Gorelick 2001). In the article by Ferris et al., 79% of the uninsured had a PCP; but of those children with health insurance 90–97% had a PCP. The proportion of children in these studies who had asthma action plans ranged from 20 to 59.3%, indicating that having a primary care provider did not necessarily coincide with receiving recommended asthma care and self-management advice (Crain et al. 1998; Dinkevich et al. 1998). Little information was available as to the content of the plans, although one study mentioned that the asthma management plan consisted of only the instructions "Go to the ED" if asthma was worsening (Davidson et al. 1994). The studies did not articulate what proportion of those with action plans followed the steps as their asthma worsened leading up to the ED visit. Of those articles that collected data on PEF meters, the proportion of children with PEF meters ranged from 13.7 to 45% (Crain et al. 1998; Dinkevich et al. 1998; Scarfone et al. 2001). Determining the use of inhaled corticosteroids among the nine studies was difficult, as the information about inhaled corticosteroid use was often presented in combination with other long-term control medications or stratified by subgroup of patients. In addition, asthma treatment

regimens change over time, and this may have been a factor in the types of medications used and the proportion of use, as the studies were conducted over a range of about 10 years. In Scarfone's cross-sectional survey, 17% of the children reported they were using ICS prior to the ED visit compared with 23% in the prospective study by Friday et al. (1997). Children interviewed in the study conducted by Farber managed their asthma primarily with albuterol (91%); only one patient used ICS (it is not known when the data were collected). The remaining studies did not report ICS use as a separate item or as a proportion of the entire study population; some stratified ICS use by health insurance coverage or by whether the patients had a regular asthma care physician. Twenty-seven percent of subjects used cromolyn, steroids, or theophylline in the study by Davidson et al. (1994); 39% of children with a RACP versus 16% with no RACP used ICS (Dinkevich et al. 1998); Ferris recorded ICS use that ranged from 13–21% by health insurance status (Ferris et al 2001); Crain's survey showed 27.1% of patients used a combination of ICS and cromolyn in the 3-month period prior to the ED visit (Crain et al. 1998); and in Stevens' paper, 5% used only ICS, 46% stated they used a combination of cromolyn, ICS, and albuterol, and 9% took cromolyn and ICS (Stevens and Gorelick 2001).

Two studies had data on patient visits to an asthma specialist in the past year; fewer than 7% of patients saw an allergist or pulmonologist, despite the facts that atopy is a strong predisposing factor for wheezing in children (Friday et al. 1997; Scarfone et al. 2001), and that in the studies for which severity of patients' asthma is known, the majority had moderate to severe asthma. Follow-up visits with primary asthma care doctors after an ED visit were reported by only two studies. These visits fell within 2–8

weeks of the ED visit, which is outside of the 5-day NAEPP recommendation (Butz et al. 1991; Stevens and Gorelick 2001).

Summary

There is a scarcity of literature documenting the adherence of asthma care and management criteria to the Guidelines among children who use the emergency department for urgent asthma treatment. Indeed, of the nine papers that did have reportable measures of NEAPP recommendations, each paper addressed on average 2.2 measures of the 7 listed in this thesis (range 1–5) (Table 5).

The *NAEPP Guidelines* for the Diagnosis and Management of Asthma have been in effect since 1991. Although they should be well integrated into clinical practice and asthma education programs, studies have shown that aspects of patient asthma care and management frequently fall short of the recommendations. From an inception cohort of clinical subjects at an urban Michigan hospital emergency department, patients' history of asthma care, education, management, preparedness for asthma exacerbations, and urgent visit follow-up compliance should reflect in part the degree to which the *NAEPP Guidelines* are being incorporated into patients' routine asthma management.

Specific aims of this thesis will include the following:

A. Describe the demographic characteristics of children with asthma who seek treatment at an urban Michigan hospital emergency department.

B. Determine the proportion of children whose asthma care and management corresponds with the following seven recommendations of the NAEPP:

1. Had ≥2 regularly scheduled asthma checkups in the past year

2. Have a PEF meter and use it

3. Take inhaled corticosteroids for moderate to severe asthma

4. Have an asthma action plan

5. Received asthma education

6. Saw an asthma specialist in the past year for those patients with moderate to severe asthma

7. Had a follow-up visit (after emergency department visit) with regular asthma care doctor by the 2-week follow-up interview

C. Describe chronic and acute asthma severity among this cohort of children by (i) categorizing underlying (chronic) severity in the 4-week period preceding the ED visit along the cutpoints of the *NAEPP Guidelines* for asthma severity; and (ii) categorizing acute severity at the ED using peak flow rates (children age 7+) as per the NAEPP and using signs and symptoms upon presentation for children <7 years.

Examining the children's routine asthma care and management prior to the ED visit will (i) provide a baseline characterization of asthma pediatric patients who use the ED for urgent care; (ii) provide insight into how well information from the Guidelines has been disseminated and incorporated into regular practice by these patients and their families in Michigan; (iii) be useful in preparing possible educational programs or clinical interventions should gaps in asthma care and self-management become evident; and (iv) help to identify areas for research into improving patient care and treatment.

Chapter 2

Study design

Emergency medicine research often makes use of single cohort or case series designs to study injury patterns, identify predictors of health outcomes, or to gather information for prevention programs (Panacek 2000). Mehta et al. used a prospective case series to investigate why patients sought ED treatment for sexually transmitted diseases (STD) when an STD clinic was situated across the street from the hospital (Mehta et al. 2000). A case report on ketamine abusers at the ED identified symptoms related to ketamine abuse (Weiner et al. 2000).

This investigation was originally designed as a prospective cohort study of children with asthma with the following objectives: (i) to describe the characteristics of children who present at emergency departments for acute asthma; (ii) to identify where gaps existed in primary asthma care and self-management measures; (iii) to document what factors may predispose ED use; and (iv) to document asthma-related outcomes 2 weeks and 6 months after the index ED visit. Three Michigan hospitals participated in the study: one urban, one suburban, and one rural. A central objective of the study was to describe how the measures listed above differed across the hospitals from three different locations.

Owing to low recruitment at two of the three hospitals, however, the comparison across the three hospitals was not possible. Only the urban site (Spectrum Butterworth) had completed enrollment of its child cohort study by September 2002. This thesis will therefore present findings from the 139 enrolled patients at this single site.

Sample size

For the original study design, a total sample size (n) of 385 participants had been estimated, or 129 per hospital, to conduct a descriptive study analysis, using an expected (worst case) prevalence (p) of 50%, a precision (ε) of ±5%, and a 95% confidence interval. The function, $z^2_{1-\alpha/2}$, denotes the percentile of interest of a standard normal distribution (Rosner 1995). The equation for calculating sample size for a population proportion is given below. The table shows several calculations based on a range of probabilities from 0.4 to 0.7.

$$n=z^2_{1-\alpha/2}(1-p)/\varepsilon^2 p$$

p	n
0.4	577
0.5	385
0.6	257
0.7	165

Study sites

Four acute care hospitals serve Grand Rapids, Michigan, and surrounding counties, primarily Kent and Ottawa, which have a combined population of 813,000. Spectrum Butterworth Hospital, located in downtown Grand Rapids, and Spectrum Blodgett Memorial Medical Center, situated in suburban Grand Rapids were selected as two study sites. Jointly the two medical facilities have 1044 beds and annually attend to 47,000 admissions and 130,000 emergency visits (Spectrum Health 2002). The third study site was Gerber Memorial Hospital, a rural community hospital with 73 beds, located in Fremont, Michigan, in the county of Newaygo, which has a population of 48,000 (US Census 2002; Gerber Memorial Health Services 2002). Fremont is situated about 40 miles northwest of Grand Rapids, MI.

Enrollment and eligibility criteria

Patient enrollment began in September 2001 and continued until participant numbers were obtained. Enrollment was limited to patients 2–17 years of age. Interviews with parents/guardians of pediatric patients were conducted in the emergency department by hospital staff trained in the study protocol.

Inclusion criteria

Potential participants were identified in two ways: (i) by interviewers who personally monitored the emergency triage area for patients with a chief complaint consistent with an asthma exacerbation, or (ii) by emergency personnel who notified off-site interviewers when patients presented at emergency with signs and symptoms consistent with an asthma exacerbation. (Interviewers were considered to be off-site when they were at their respective offices, which were housed in an adjacent hospital building.) To be eligible for the study, patients had to have signs and symptoms consistent with an asthma exacerbation (i.e., wheezing, shortness of breath, chest tightness, or cough) and have a final ED diagnosis of asthma or any one of the following: a previous physician diagnosis of asthma (ever) or reactive airway disease (ever) or a history of bronchodilator medication use (excluding over the counter medication) in the last year (see Screening Criteria Appendix A & B).

Exclusion criteria

Patients were excluded if they met one or more of the following criteria:

- Life-threatening respiratory distress

- Other significant illnesses such as any major chronic disease or disability, including HIV/AIDS, immunodeficiency, cystic fibrosis, bronchopulmonary dysplasia, or other chronic cardiopulmonary disease
- Cognitive impairment on the part of the parent such that their ability to follow medical advice would be significantly impaired
- No fixed address or not available for follow-up
- Unable to communicate in English or Spanish
- Already participating in another intervention study or asthma study

Asthma care in the Butterworth Hospital Emergency Department

Typically patients seeking treatment at the ED approached the triage nurse in the emergency department. Patients were then seen by an attending physician and examined. If a determination of either asthma symptoms or an asthma exacerbation was made, an on-site respiratory therapist if available performed an initial lung function assessment using pulse oximetry (PaO_2), and in children ≥7 years of age, took peak expiratory flow (PEF) measurements. If required, treatment with a short-acting bronchodilator (albuterol) was begun immediately to forestall further deterioration. Once treatment was underway, the patient's history was taken and a physical examination was made noting the signs and symptoms of the exacerbation. A patient may exhibit several, but not necessarily all, signs and symptoms typical of an asthma exacerbation (breathlessness, affected speech, wheezing, labored breathing, and coughing), which will determine the severity classification of the exacerbation.

A respiratory therapist or ED nurse monitored the patients approximately every 20 minutes after administration of albuterol in the first hour; oxygen saturation and PEF

were measured for an indication that the exacerbation was abating. For moderate and severe exacerbations, if patient response to albuterol was not immediate, oral or intravenous systemic corticosteroids were administered. Supplemental oxygen was given if patients had significant hypoxemia. If a good response was seen after treatment, i.e., PEF ≥70%, and the patient was stable and no longer in distress, then the patient was discharged. The physician would use clinical judgement to determine if hospitalization was necessary when the patient showed an incomplete response to treatment, for example, if PEF ≥50 but <70%. Patients with a PEF <50% after treatment were generally admitted to the hospital. In infants, an oxygen saturation of <91% on room air was generally considered an indication for hospitalization.

While the patient waited for medication to take effect, and if time permitted, the respiratory therapist or nurse reviewed with the patient and family what to do during an exacerbation, and provided patients with educational materials about asthma triggers and instruction on how to use asthma equipment, such as a peak flow meter and a metered dose inhaler with spacer.

Discharge instructions were given to the patient's parent and a copy was sent to the primary care doctor. Asthma patients at discharge were typically prescribed a short course of oral steroids (5 days). The patients were advised to make a follow-up appointment with their primary asthma care doctor as soon after the ED visit as possible to review their medications and asthma management plan.

Data collection

Information on demographics, usual asthma care and management practices and utilization of health services in the past year, asthma severity, and post ED visit asthma-

related outcomes was collected from pediatric patients attending emergency departments at the three aforementioned hospitals for treatment of their asthma. Funding permitted the staffing of one study coordinator, who was located at the Butterworth campus and was assisted by a research nurse and medical student, to implement and conduct the study. As Blodgett and Gerber Hospitals typically do not see enough asthma patients to warrant hiring research staff, on-staff respiratory therapists at Blodgett and Gerber Hospitals were trained by the study coordinator with the expectation that they would screen potential participants, obtain informed consent and enroll patients, and conduct interviews at their respective sites. Available staff at Butterworth Hospital (1.5 full-time equivalents) provided an average of 60 hours per week of coverage. A medical student worked occasional night and weekend shifts up to 16 hours per week of additional coverage. Data collected then were representative of patients who visited during the day and evening hours; but as there was little overnight coverage, patients who sought urgent asthma treatment after 11:00pm were underrepresented in this sample.

Informed consent

When interviewers identified a patient in the ED with asthma symptoms, they approached the parents while the child was being treated to make a determination of eligibility. After the interviewer completed the screening criteria form (Appendix B) and determined eligibility, she informed parents and children about the objectives and procedures of the study and asked if they and their child were interested in participating. Patients were not paid to participate nor were there any direct benefits from being in the study. A screening log was used to record reasons for inclusion or exclusion for those

patients who met the definition of asthma (see Screening Log, Appendix C). Interviews did not commence until informed written consent was obtained from the parents or guardians and assent was received from the children (see Consent and Assent Forms, Appendix D–F). Parents gave consent for their children less than 18 years (Consent Form, Appendix D); a separate assent form was signed by children between the ages of 7 and 14 years (Assent Form, Appendix E); and youths aged 15–17 years gave their own signed consent (Assent Form, Appendix F). All participants were given a copy of their signed informed consent/assent forms with the telephone numbers of contact persons in the event that they had any questions or concerns about the study.

The study was approved by the institutional review boards at Michigan State University, Spectrum Health, the Michigan Department of Community Health, and the Centers for Disease Control and Prevention.

Emergency visit interview

Interviewers completed a 31-item questionnaire in the ED with the family and patient (see Child Cohort Visit Form, Appendix G). The questionnaire was organized into six sections pertaining to patient demographic information, asthma history, usual asthma care, current asthma treatment, management and control, emergency asthma care, and general awareness about asthma.

Baseline characteristics—The following sociodemographic information was collected for each participant: birthdate, sex, race and ethnicity, education level of the attending parent, and child's health insurance status (see section A, Child Cohort Visit Form, Appendix G). Patients were asked whether their asthma had been previously

diagnosed by a doctor and at what age they had been diagnosed (see section B, Child Cohort Visit Form, Appendix G).

Asthma severity—To assess the level of underlying asthma severity in the 4 weeks prior to the emergency department visit, patients were asked four questions: (1) what was the frequency of daytime asthma symptoms, (2) what was the frequency of nighttime asthma symptoms; (3) the number of times over this 4-week period that the child's activities had been affected or restricted; and (4) the number of times in the 4-week period that exacerbations severe enough to limit the child's speech had occurred (see section B, Child Cohort Visit Form, Appendix G).

Usual asthma care—Patients were first asked if they had a primary care provider and then if they had a regular asthma care provider (RACP), i.e., a health professional, such as a family doctor or pediatric nurse practitioner, who took primary responsibility for the child's asthma care. To establish whether patients were receiving regular asthma care, parents were asked how many times in the past year children had made regularly scheduled visits to their asthma care providers and how long it had been since the last visit. For those without a primary care provider, participants were asked from what type of doctor, provider, or clinic they received regular asthma care. Interviewers queried whether patients with a regular asthma care provider (RACP) had visited an asthma specialist in the past year (see section C, Appendix G.)

Current asthma treatment and self-management—All names of prescription and non-prescription medications taken in the preceding 4 weeks (including doses prescribed, current frequency of use, route, whether the drug had run out and if used in last 4 weeks) were recorded from patients' self-reports (see section D, Appendix G).

Separate questions were asked specifically about the use of systemic steroids and inhaled corticosteroids. To determine whether access to medications was an issue, a question was included about the family's ability to get prescriptions filled. Self-monitoring practices of patients were assessed by enquiring of patients if they had a spacer and a peak flow meter (PFM) and how frequently they used these devices. Parents were asked whether their children had ever been given a written asthma action plan. With respect to asthma education, parents were asked whether they and their child had ever received education about asthma control and treatment from a health professional. They were then asked what they had specifically learned: things that trigger their asthma; medications and treatments; how to use a PFM; how to use an inhaler or nebulizer; how to use a written asthma action plan; and what to do during an asthma attack.

History of emergency care—Patients' self-reported history of the following was documented: ever hospitalized for treatment of asthma symptoms; ever gone to the emergency department for urgent treatment of asthma symptoms (before this visit); and number of hospitalizations, emergency visits, and urgent care visits (at a doctor's office or clinic) in the past year (see section E, Appendix G). Parents were also asked where they usually took their child when he/she was experiencing problems with asthma and their reasons for selecting that particular health care option.

Asthma awareness— To measure general understanding about asthma, parents answered true or false to the following three statements: (i) "most people with asthma can become free of asthma with proper treatment," (ii) "asthma is characterized by inflammation of the airways, which if controlled, can greatly reduce symptoms," and (iii)

"if someone with asthma feels well, it is okay to stop taking their medication" (see section F, Appendix G).

Chart abstraction

Following the ED visit, the interviewers abstracted relevant clinical information from medical charts onto a clinical data form (see Clinical Data Form, Appendix H). Information collected included initial signs and symptoms upon presentation (breathlessness, speech, breath sounds, degree of labored breathing, and presence of cough); peak flow and oximetry measurements; treatments received in the ED; discharge medications; asthma supplies and education received while in the ED; and any follow-up reminders and referrals given.

The table on asthma signs on presentation shown in section 4 of the clinical data form (Appendix H) was constructed based on the *NAEPP Guidelines*.

Follow-up interviews

The cohort of Butterworth children was followed up on two occasions: two weeks and six months following the initial ED visit. Research staff at Butterworth conducted all follow-up telephone interviews with parents and entered all data into a Microsoft Access® database.

Two-week follow-up survey—Two weeks after the initial ED visit, interviewers contacted the parents or guardians of the patients by telephone for a follow-up interview (see Child Cohort 2-week Follow-up Form, Appendix I). Ideally the parent who had accompanied the child to the emergency department was interviewed or if this were not possible, then another family member who was familiar with the child's asthma care was asked to do the telephone interview. The 2-week questionnaire comprised 19 items

about additional urgent care visits for asthma and routine asthma visits since the ED visit (see sections A & B, Appendix I); whether a follow-up appointment had been made with the child's primary asthma care provider after the index ED visit (see section B, Appendix I); compliance with discharge prescriptions (see section C, Appendix I); and four questions on current asthma symptoms, three on asthma control, and two on quality of life (see section D, Appendix I).

Six-month follow-up survey—Parents were again contacted by interviewers by telephone six months following the ED visit. The 25-item 6-month questionnaire asked about the occurrence of asthma exacerbations since the 2-week interview that necessitated taking the child for urgent treatment, and if so, where the child was taken (see Child Cohort 6-Month Follow-up Form, Appendix J). All reported urgent care and ED visits and hospitalizations were recorded (see section A, Appendix J). If the child had not seen their regular asthma care provider by the time of the 2-week interview, the parents were asked at 6 months when the child had their follow-up asthma check-up (see section B, Appendix J). Parents were queried how many routine asthma care visits the child had had since the 2-week interview and about any changes to the child's asthma management. On the six-month follow-up form, information was recorded about current asthma-related medications the child had been taking in the 4 weeks leading up to the 6-month interview (see section C, Appendix J). Interviewers asked the parents for an assessment of the child's recent asthma symptoms and control, and quality of life in the last 4 weeks (see section D, Appendix J).

Defining asthma severity

Chronic and acute severity were measured in two ways: (1) chronic underlying asthma severity during the 4-week period prior to going to the ED, and (2) clinical severity upon presentation, as measured by peak expiratory flow (PEF) measurements taken in the ED (children ≥7 years) and (or) by signs and symptoms of asthma upon examination.

Chronic (long-term) severity

An aggregate variable was created to define a patient's overall underlying asthma severity, which was characterized according to the most severe grade of either day- or night-time symptoms, restricted activities, or the frequency of exacerbations severe enough to affect speech that occurred over the 4-week period preceding the index ED visit. Questions 7–10a from ED visit form (Appendix G) are reproduced below demonstrating the cutpoints for defining mild intermittent, mild persistent, moderate persistent, and severe persistent in accordance with the NHLBI guidelines (see Table 1 on NAEPP classification of asthma severity).

7. How often in the last 4 weeks has your child had asthma symptoms **during the day**? (i.e., wheezing, a dry cough, shortness of breath, and/or chest tightness)

Never	01	*Mild intermittent*
Less than once a week	02	
1 or 2 times a week	03	
3 to 6 times a week	04	*Mild persistent*
Every day	05	*Moderate persistent*
Continually (all the time)	06	*Severe persistent*

8. How many times over the last 4 weeks did your child **wake up at night** because of asthma symptoms? (i.e., wheezing, a dry cough, shortness of breath, and/or chest tightness)

Never	01	*Mild intermittent*
1 or 2 times	02	*Mild intermittent*
3 to 4 times	03	*Mild persistent*
5 to 9 times	04	*Moderate persistent*
10 or more times	05	*Severe persistent*

9. How many times over the last 4 weeks has your child's activities been **affected or restricted** by his/her asthma symptoms?

Never	01	*Mild intermittent*
1 or 2 times	02	*Mild persistent*
3 to 4 times	03	*Moderate persistent*
5 or more times	04	*Severe persistent*
All the time	05	*Severe persistent*

10. In the last 4 weeks has your child's asthma symptoms ever been severe enough to limit your child's speech to only 1 or 2 words at a time between breaths? No/Yes

10a. If yes, how many times has this occurred in the last 4 weeks? ____

Children were assigned to the moderate persistent level of severity if they experienced ≥8 but <20 exacerbations in the past month, and to severe persistent if they reported ≥20 severe episodes of asthma.

To give an example of classifying chronic asthma severity, if a child reported daytime symptoms less than once a week, five episodes of nighttime symptoms in the

past 4 weeks, had activities restricted twice in the past month, and four exacerbations, this child would be classified with moderate persistent severity.

Acute (exacerbation) severity

A measure of acute severity, representing the current exacerbation, was obtained by documenting the patient's asthma signs and symptoms upon presentation in the emergency department and (or) the degree of airflow limitation as measured by PEF (see Table 1). Severity of the exacerbation was classified based on respiratory symptoms according to Table 6.

Table 6. Classification of acute severity based on presenting signs and symptoms

Sign	Normal	Mild	Moderate	Severe
Breathless-ness	None	While walking	While talking	While at rest
Presenta-tion	Relaxed	Mildly anxious Normal speech	Anxious Speaks short phrases	Tense, unable to speak more than 1-2 words between breaths
Breath Sounds	Clear	Rales/ronchi Mild/scattered wheezing	Poor aeration Moderate/ entire expiratory wheezing	Minimal aeration Audible wheezes Insp/exp wheezes
Work of Breathing	None	Mild intercostal retractions Mild AMU	Moderate Substernal retractions Moderate AMU	Severe Supraclavicular retractions Severe AMU
Cough	None	Intermittent	Frequent	Constant

Note: Adapted from the *1997 NAEPP Guidelines*.

The highest degree of breathing and speech difficulties was used to define the overall level of acute asthma severity. Thus, a child with an intermittent cough, who became breathless while talking, and from whom audible wheezing could be heard, would be classified as having a severe exacerbation.

In addition, for patients aged ≥7 acute severity was measured using PEF and compared with either their personal best readings or predicted values. Predicted values were calculated from patients' age and height, according to a predicted PEF table. A simplified version of a predicted PEF table based on height is given below.

Table 7. Predicted PEF values based on height

Height (cm)	PEF rate (L/min)*
120	215
130	260
140	300
150	350
160	400
170	450
180	500

Note: *, mean; 2 SD = ±100.
From Monash University (2003)

PEF readings were taken pre- and post-medication while the child was in the ED. For some cases several values post-treatment were obtained if the response to medication was slow. If the pre-medication PEF reading was ≥80% of the predicted value, then asthma severity was classified as mild. Asthma was classified as moderate severity when the pre-treatment PEF measurement was >60% but ≤80% of the predicted value. For pre-treatment PEF measurements ≤60% of predicted, asthma was categorized as severe.

Measures based on recommendations from the *NAEPP Guidelines*

Questions on patient asthma care, education, and self-management histories from the survey instruments provided data for comparison with several NAEPP recommendations. Each measure below will be used to identify a proportion of pediatric patients who reportedly met an NAEPP criterion among those enrolled in the study.

Measure 1 concerns the number of regularly scheduled asthma care visits to a primary asthma care provider in the past year, categorized as <2 visits and ≥2visits (Q14 on the ED visit form). The NAEPP advises at least two scheduled check-ups a year for individuals with mild intermittent or mild persistent asthma, and more frequent check-ups for those with moderate and severe asthma.

Measure 2 determines the proportion of patients age 7 and older with moderate to severe asthma who had a peak flow meter (Q22) and how frequently they used it (Q22a). The NAEPP recommends that children aged 5 years and older, with a history of moderate to severe asthma, use a peak flow meter to monitor both the severity of an exacerbation and how well they are responding to pharmacotherapy.

Measure 3 addresses the use of inhaled corticosteroids taken by patients in the 4 weeks preceding the ED visit (Q17). Patients older than age 5 with persistent asthma are recommended to take inhaled corticosteroids (low dose for mild asthma, low to medium dose for moderate asthma, and a high dose for severe asthma) to maintain long-term control of their asthma. The NAEPP counsels that children with asthma age 5 and younger can be treated with low dose ICS for mild persistent and moderate asthma, and high dose ICS for severe asthma (NAEPP 2002).

Measures 4 and 5 address the issues of a written asthma action plan and education in dealing with asthma. The ED visit form asked participants whether they had been given a written asthma action plan by their health care provider (Q23) and whether they had received education on asthma control and treatment (Q24–25). Question 24a queried patients about the specific type of asthma education they had received (asthma

triggers, medications and treatments, how to use an inhaler or a nebulizer, how to use a peak flow meter, what to do during an asthma attack, and how to use a written action plan).

Measure 6 addresses visits to an asthma care specialist for patients who have moderate to severe persistent asthma. Two questions on the ED visit form that collected data on asthma specialists ask participants (1) who have a RACP whether they have seen an asthma specialist in the past 12 months (Q16) or (2) who don't have a RACP, what type of doctor or provider or clinic takes primary responsibility for their regular asthma care (Q13).

Measure 7 addresses the proportion of patients who had a follow-up appointment after the index ED visit. Two questions on the 2-week follow-up questionnaire sought to establish whether the child had attended a follow-up visit with their RACP (Appendix I, Q8b) or an appointment had been made for the follow-up by the time of the 2-week interview (Appendix I, Q), given that it is sometimes difficult to get an appointment on short notice. These questions do not explicitly measure compliance, as to do so would require confirmation with the patient's physician that the appointment took place (Leickly et al 1998).

Statistical analyses

Data from the interviews and the clinical data forms were entered into a Microsoft Access® database by the interviewers at the hospitals. As the data became available, periodic checks of the completeness and quality of the data were undertaken by research staff at the Department of Epidemiology, Michigan State University. Quality assurance reports were sent back to the hospital study coordinator to locate missing data or to interpret nonstandard responses and illogical skip patterns.

Statistical analyses are listed by study objective:

A. Demographic characteristics: Proportions of demographic characteristics with 95% confidence intervals were calculated for dichotomous categorical variables using Proc Freq in SAS v8.2 (SAS Institute Inc., Cary, NC). The mean values (±95% confidence intervals) of continuous variables (such as patient age, number of routine asthma visits) were calculated using Proc Means.

B. Seven NAEPP recommendations: Frequencies (using Proc Freq) with 95% confidence intervals were calculated for the seven NAEPP exposure measures under study.

An array procedure followed by Proc Freq was applied to determine the proportion of patients taking each of the different medication groups.

A subgroup analysis compared adherence to the NAEPP recommendations between children who had seen an asthma specialist and those who had not (using Pearson's chi-square test or Fisher's exact test if at least one cell in the contingency table was less than 5). Statistical significance was set at $p<0.05$.

C. Asthma severity: Aspects of asthma care, treatment, and management, hospitalization and ED visits, and follow-up visits and relapses (categorical variables) were cross-tabulated with chronic severity using Proc Freq and tested for linear trend using the Mantel-Haenszel test ($p<0.05$). An acute severity construct categorized the severity of the ED exacerbation as previously described. Patients' level of chronic asthma severity was also correlated with acute severity at the time of the ED visit.

Chapter 3

Enrollment

Enrollment over the first year of the project was slower than expected at Blodgett and Gerber Hospitals. Between July 2001 and September 2002, only 14 children were enrolled at Gerber Hospital and 20 at Blodgett Hospital. However, enrollment at Butterworth Hospital went well and 139 children were enrolled by September 2002, exceeding the original goal.

Respiratory therapists, who had been trained to recruit and interview patients, were on staff 24 hours a day at Gerber and Blodgett Hospitals. However, owing to other hospital-wide responsibilities, they were not always available in the ED to enroll patients. Unlike the situation at Gerber and Blodgett, because of the higher volume of asthma patients, Butterworth had research staff who worked solely on the project.

With so few study participants from Gerber and Blodgett Hospitals, it was not possible to do a comparative analysis across the three hospital sites. Instead, we performed a descriptive analysis on the data collected from the 139 patients from Butterworth Hospital.

Baseline characteristics of participants

The mean age of the 139 children was 8.4±0.7 years, with a range of 2–17 years (Table 8). One quarter of the patients (25.9%, n=36) were less than 5 years of age; males comprised 61.1%, and African Americans made up 28.1% (n=39) of the cohort. Close to half of the parents (44.6%) had achieved no higher than a high school education;

according to 2000 US census estimates, 45.1% of adults 25 years and over have a high school education.

Table 8. Baseline characteristics of children

Characteristics	*n*	Frequency (%)
Number enrolled	139	
Age		
2–4 years	36	25.9
5–9 years	50	36.0
10–14 years	38	27.3
15–17 years	15	10.8
Gender (%± 95%CI)		
Females	68	41.2±8.1
Males	97	58.8±8.1
Hispanic (% ± 95%CI)	21	15.2±5.9
Race (%)		
Black/African-American	39	28.1
White/Caucasian	84	60.4
Multiple	13	9.3
Other	3	2.2
Parent education (%)		
<High school	19	13.7
High school grad	43	30.9
1–3 years college	47	33.8
≥College grad	30	21.6
Insurance status (%)		
HMO/PPO	31	22.3
Medicaid HMO	65	46.8
Private/commercial	40	28.8
Self-pay/none	3	2.1
Patients with physician-diagnosed asthma (%±95%CI)	118	84.9±5.9
Age when diagnosed (%)		
<2 years	61	52.1
2–4 years	41	35.0
5–9 years	11	9.4
10–14 years	3	2.6
15–17 years	1	0.9

Almost half of the patients (46.8%) enrolled in this study had health insurance coverage through Medicaid or a Medicaid health maintenance organization (HMO), and only 2.1% (n=3) were without health coverage.

The majority of patients at 84.9% (n=118) had been previously diagnosed with asthma by a physician; more than half had been diagnosed before the age of 2 years (52.1%), while 87.1%, had been diagnosed before they were 5 years old.

Recent history of asthma symptoms

Frequencies of daytime and nighttime symptoms, the number of times their child's activities were restricted due to asthma symptoms, and the number of asthma exacerbations in the 4 weeks prior to the ED visit as estimated by parents are shown in Table 9.

Table 9. Reported asthma symptoms before the ED visit

Severity indicators	***n***	**%**
1. Day symptoms		
Never	44	31.6
<Once a week	30	21.6
1–2 times a week	29	20.9
3–6 times a week	16	11.5
Daily	19	13.7
Continually	1	0.7
2. Night symptoms		
Never	68	48.9
1–2 times	32	23.0
3–4 times	16	11.5
5–9 times	4	2.9
≥10 times	19	13.7
3. Restricted activities		
Never	88	63.3
1–2 times	23	16.6
3–4 times	12	8.6
≥5 times	9	6.5
Continually	7	5.0
4. Exacerbations (%±95%CI)		
Yes	28	20.1±6.7
No	111	79.9±6.7

A large proportion of children (27.3%) experienced no asthma symptoms at all in the 4-week period leading up to the ED visit: 31.6% (n=44) had no daytime symptoms; 48.9% (n=68) were without symptoms at night; and 63.3% (n=88) did not consider their underlying asthma severe enough to limit any activities. Twenty-eight children (20.1%) reported having at least one asthma exacerbation in the past 4 weeks (defined as symptoms that limited their speech to one to two words).

Classifying chronic severity

Following the NAEPP symptom-based classification system for chronic asthma severity, the highest frequency of day- and night-time symptoms, restricted activities, or of exacerbations determined the classification level of chronic severity.

Table 10. Two methods of classifying chronic asthma severity

Severity based on different criteria	***n***	**% of patients**
Chronic severity + exacerbations[a] (n=139)		
Mild intermittent	64	46.0
Mild persistent	21	15.1
Moderate persistent	18	13.0
Severe	36	25.9
Chronic severity[b] (n=139)		
Mild intermittent	67	48.2
Mild persistent	24	17.3
Moderate persistent	20	14.4
Severe	28	20.1

[a]Underlying severity determined by highest grade of severity among frequency of day and night symptoms, restricted activities and exacerbations in 4 weeks prior to ED visit.

[b]Underlying severity determined by highest grade of severity among frequency of day and night symptoms and restricted activities (no exacerbations) in 4 weeks prior to ED visit.

The chronic severity distribution among the cohort was as follows: 48.2% mild intermittent (n=67); 17.3% mild persistent (n=24); 14.4% moderate (n=20); and 20.1% severe (n=28) (Table 10). Inclusion of frequency of exacerbation in the construct did not

appreciably change the frequency distribution of chronic severity (Table 10). Figure 3 shows the contribution of daytime, nighttime, and restricted activities to the chronic severity construct.

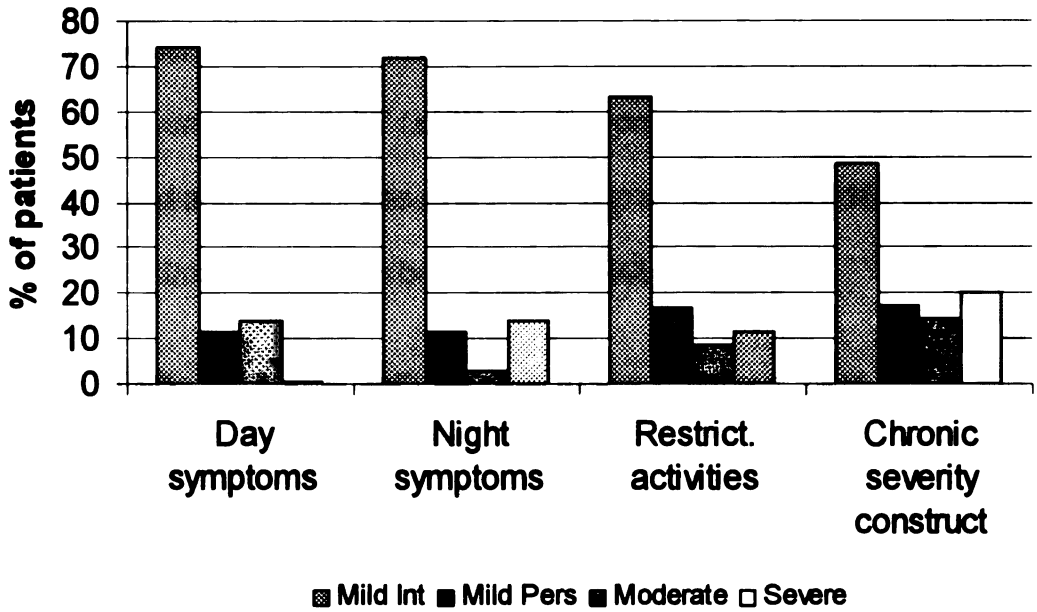

Fig. 3. Contribution of individual symptoms to the chronic severity construct

Usual asthma care history

Almost all participants reported that they had a primary care provider (PCP; n=132, 95.0±3.6%). Of these patients, 84.9±11.3% stated that their primary care doctor was their regular asthma care provider (RACP), defined as the physician who took primary responsibility for their asthma and wrote their prescriptions (Table 11). Among those children who received regular asthma care (RAC) from their PCP, 16.4% (n=20) had also visited an asthma specialist in the past year. Of the 27 children who either did not have a PCP or their PCP did not provide RAC, 63.0% (n=17) received RAC from an asthma specialist. Eight children (29.6%) went to an ED or urgent care center and one

(3.7%) attended another type of clinic for RAC, while one other (3.7%) reported no source for regular asthma care.

Almost one quarter of the cohort did not attend any regularly scheduled appointments for asthma care in the past year (23.7%, n=32) (Table 11). Among those who did have regularly scheduled appointments with their physician, the mean number of routine asthma visits was 2.7±0.7 (±95% CI). The proportion of patients whose last regularly scheduled appointment was over a year ago was 13.2% (n=16), while 54.6% had had an appointment ≤3 months before the ED visit.

Table 11. Usual asthma care in the previous year

Indicators	*n*	Frequency
Primary care provider (PCP) (%±95% CI)		
Yes	132	95.0±3.6
No	7	5.0±3.6
PCP is RACP		
Yes	112	84.9±11.3
No	20	15.1±11.3
Source of regular care if not PCP (%)		
None	1	3.7
ED / Urgent care center	8	29.6
Specialist	17[b]	63.0
Other (clinic)	1	3.7
Saw asthma specialist[a] (%±95% CI; n=122)	20[b]	16.4±6.6
Regularly scheduled app'ts (%; n=135)		
None	32	23.7
1 app't	30	22.2
2 app'ts	23	17.0
3–5 app'ts	33	24.4
≥ 6 app'ts	17	12.6
Last regularly sched. app't (%; n=121)		
≤1 month ago	25	20.7
1–3 months ago	41	33.9
4–6 months ago	26	21.5
7–12 months ago	13	10.7
>12 months ago	16	13.2

Note: PCP, primary care provider; RACP, regular asthma care provider.
[a]When RACP is PCP, not specialist. [b]A total of 37 children had seen a specialist.

Patients who saw asthma specialists

A total of 37 children saw an asthma specialist in the past year. A significantly higher number of children who had visited a specialist reported that they had received a written asthma action plan (73.0% versus 31.4%, $p<0.0001$, Pearson's χ^2 =19.2, 1 df) and asthma education than those who did not (89.2% versus 68.6%, $p=0.0145$, Pearson's χ^2 =6.0, 1 df). Inhaled corticosteroid use was significantly higher in children who had visited a specialist (70.3%) compared with those who hadn't (37.3%, $p=0.0006$, Pearson's test $\chi^2=11.9$, 1 df). Children who had seen a specialist were more likely to have a peak flow meter (84% with a specialist versus 58.9% without, $p=0.027$, Pearson's test $\chi^2=4.9$, 1 df). Almost 24% of children with a specialist took PFM readings daily as opposed to 9.1% of those without a specialist. Neither the occurrence of relapse visits for asthma over the 2-week period nor follow-up visits with RACP was significant between the two groups of children (relapse visits, $p=0.5308$, Fisher exact test; follow-up, $p=0.4027$, Pearson's $\chi^2=0.7$, 1 df).

Emergency care history

Just over half of the children (54.0±8.3%) had been hospitalized for asthma in their lifetime; 57.3% reported at least one in-patient visit within the last year. The majority of the children at 86.3±5.7% had a prior history of seeking urgent asthma treatment at an emergency department (Table 12A). More than three quarters of the patients (76.7%) had made at least one ED visit in the preceding year. When asked how many urgent visits were made to a doctor or clinic in the past year, almost 60% had made at least one; the mean number of urgent visits in the previous year to a doctor or clinic was 2.2±0.6.

Table 12A. Emergency care in the past year

Indicators	**n**	**Frequency**
Ever hospitalized for asthma (%±95% CI)	75	54.0±8.3
Hospitalized in past year (%; n=75)		
None	32	42.7
Once	34	45.3
2–5 times	9	12.0
Ever made ED visit for asthma (%±95% CI)	120	86.3±5.7
ED visits in past year (n=120)		
None	28	23.3
1 ED visit	41	34.2
2 ED visits	19	15.8
3–5 ED visits	16	13.3
≥6 ED visits	16	13.3
Urgent visits in past year to doctor/clinic (n=139)		
None	56	40.3
1 urgent visit	27	19.4
2 urgent visits	21	15.1
3–5 urgent visits	21	15.1
≥6 urgent visits	14	10.1

Table 12B. Hospitalizations for asthma by chronic severity

Chronic severity	**Ever hospitalized**		**Hospitalized in past year**	
	Yes (n=75)	**No** (n=64)	**None** (n=96)	**≥1** (n=43)
MI (%)	43 (50.8)	33 (49.2)	48 (71.6)	19 (28.4)
MP (%)	14 (58.3)	10 (41.7)	18 (75.0)	6 (25.0)
Moderate (%)	11 (55.0)	9 (45.0)	12 (60.0)	8 (40.0)
Severe (%)	16 (57.1)	12 (42.9)	18 (64.3)	10 (35.7)
MH test				
X^2	0.35		0.90	
p	0.5565		0.3415	

Note: MI, mild intermittent chronic asthma; MP, mild persistent chronic asthma; MH, Mantel-Haenszel test.

Table 12C. ED visits for asthma by chronic severity

Chronic severity	Ever had ED visit		ED visits in past year	
	Yes (n=120)	**No** (n=19)	**None** (n=47)	**≥1** (n=92)
MI (%)	56 (83.6)	11 (16.4)	25 (37.3)	42 (62.7)
MP (%)	23 (95.8)	1 (4.2)	7 (29.2)	17 (70.8)
Moderate (%)	18 (90.0)	2 (10.0)	9 (45.0)	11 (55.0)
Severe (%)	23 (82.1)	5 (17.9)	6 (21.4)	22 (78.6)
MH test X^2 p	<0.01 0.9622		0.11 0.2923	

Note: MI, mild intermittent chronic asthma; MP, mild persistent chronic asthma; MH, Mantel-Haenszel test.

Table 12D. Urgent care doctor visits for asthma by chronic severity

Chronic severity	ED visits in past year		
	None (n=56)	**1–2** (n=48)	**>2** (n=35)
MI (%)	36 (53.7)	23 (34.3)	8 (11.9)
MP (%)	6 (25.0)	10 (41.7)	8 (33.3)
Moderate (%)	4 (20.0)	8 (40.0)	8 (40.0)
Severe (%)	10 (35.7)	7 (25.0)	11 (39.3)
MH test X^2 p	0.89 0.3452		

Note: MI, mild intermittent chronic asthma; MP, mild persistent chronic asthma; MH, Mantel-Haenszel test.

We tested the association between chronic severity and emergency care history, however, no statistically significant associations were found for any of the five measures evaluated (Tables 12B–12D).

Asthma treatment

Asthma drugs used by children in the 4-week period prior to their ED visit as reported by their parents were classified into major medication groups outlined by the NAEPP. Long-term control medications include any of the following: inhaled corticosteroids (ICS), cromolyn sodium, nedocromil, long-acting β_2-agonists (LABA), combined corticosteroid + long-acting β_2-agonist (e.g., Advair), methylxanthines (theophylline), and leukotriene modifiers (LM). Short-term control or quick relief medications include short-acting β_2-agonists (SABA), anticholinergics, and systemic (oral) corticosteroids (OC).

Table 13A. Reported medication use in 4-week period before ED visit

Medication treatments	***n***	**%Patients on medication** (± 95% CI)
Long-term control[a]		
ICS (Pulmicort, Flovent)	64	46.0±8.3
LABA (Serevent)	13	9.4±4.8
Cromolyn or nedocromil (Intal, Tilade)	5	3.6±3.1
LM (e.g., Singulair)	24	17.3±6.3
CSBA (e.g., Advair)	20	14.4±5.8
Theophylline	1	0.7±1.4*
Short-acting control[a]		
SABA (e.g., albuterol)	118	84.9±6.0
Anticholinergics (e.g., Atrovent)	5	3.6±3.1
Oral corticosteroids (%)	28	24.8
Miscellaneous		
Allergy medications (e.g., Zyrtec)	25	18.0±6.4
Nasal sprays (e.g., Flonase)	11	7.9±4.5

Note: CSBA, corticosteroid + long-acting β-agonist combined; ICS, inhaled corticosteroid; LM, leukotriene modifiers; LABA, long-acting β-agonist; SABA, short-acting β-agonist.

[a]Categories of medications as per the NAEPP (2002)

*CI exceeds 95% possible limits.

Based on parents' reports, each child used an average of 2.7 medications for their asthma in the 4-week period prior to coming to the ED. SABA (e.g., albuterol) and ICS (such as budesonide or fluticasone) were the most common prescription medications used (Table 13A).

We evaluated the association between the level of chronic severity and medication use (Table 13B). Reported use of SABA was high across all levels of severity but was not associated with increasing severity (p=0.146). Statistically significant associations were identified between severity and ICS, LABA, LM, and OC use. ICS use was reported by 58.3±11.4% of children with persistent asthma and by almost 70% (67.9±17.3%) of patients with severe persistent asthma.

Appropriateness of medication use

Eighteen children (13.0±5.6%) were not taking any asthma medication, either short- or long-acting; 15 of these were mild intermittent, however, 3 were considered to have moderate to severe chronic asthma. Fifty-eight percent of moderate to severe asthma patients were undertreated. Almost 20% (18.8%) of these children were not taking any long-term control medication (Table 13C). The proportion of patients with moderate to severe asthma who were taking the following drugs as their only long-term control medication was as follows: ICS only, 37.5% (n=18); and LABA and leukotriene modifiers, 2.1% (n=1).

Table 13B. Medication use in 4 weeks prior to ED visit by chronic asthma severity

	SABA (n)		**ICS** (n)		**LABA** (n)		**CSBA** (n)		**LM** (n)		**Oral steroids** (n)	
Chronic severity (%)	Yes (118)	No (21)	Yes (118)	No (21)	Yes (118)	No (21)	Yes (118)	No (21)	Yes (118)	No (21)	Yes (118)	No (21)
MI (n=67)	52 (77.6)	15 (22.4)	22 (32.8)	45 (67.2)	1 (1.5)	66 (98.5)	8 (11.9)	59 (88.1)	7 (10.5)	60 (89.6)	9 (13.4)	58 (86.6)
MP (n=24)	24 (100.0)	0 (0)	11 (45.8)	13 (54.2)	3 (12.5)	21 (87.5)	4 (16.7)	20 (83.3)	4 (16.7)	20 (83.3)	6 (25.0)	18 (75.0)
Mod (n=20)	17 (85.0)	3 (15.0)	12 (60.0)	8 (40.0)	3 (15.0)	17 (85.0)	5 (25.0)	15 (75.0)	5 (25.0)	15 (75.0)	4 (20.0)	16 (80.0)
Sev (n=28)	25 (89.3)	3 (10.7)	19 (67.9)	9 (32.1)	6 (21.4)	22 (78.6)	3 (10.7)	25 (89.3)	8 (28.6)	20 (71.4)	9 (32.1)	19 (67.9)
MH test X^2	2.11		11.46		10.22		0.12		5.42		3.89	
p	0.1460		**0.0007***		**0.0014***		0.7311		**0.0198***		**0.0485***	

Note: CSBA, corticosteroid + β-agonist combined; ICS, inhaled corticosteroid; LM, leukotriene modifier; LABA, long-acting β-agonist; SABA, short-acting β-agonist; MI, mild intermittent chronic asthma; MP, mild persistent chronic asthma; Mod, moderate severity; Sev, severe severity; MH, Mantel Haenszel test (1df).
*Significant trend.

Table 13C. Long-term control medication use pre-ED visit by chronic severity

Chronic severity (%)	ICS+LABA (n=31)	ICS+Alt Tx (LM, CN) (n=9)	ICS only (n=41)	LTC meds only (no ICS) (n=4)	No LTC or ICS Tx (n=54)
MI (n=67)	9 (13.4)	2 (3.0)	18 (26.9)	2 (3.0)	36 (53.7)
MP (n=24)	7 (29.2)	2 (8.3)	5 (20.8)	1 (4.2)	9 (37.5)
Mod/Sev (n=48)	15 (31.3)	5 (10.4)	18 (37.5)	1 (2.1)	9 (18.8)

Note: Alt, alternative treatment; CN, cromolyn or necrodomil; ICS, inhaled corticosteroids, LABA, long-acting β-agonist; LM, leukotriene modifier; LTC, long-term control; MI, mild intermittent asthma; MP mild persistent chronic asthma; Mod/Sev, moderate to severe persistent asthma; TX, treatment.

Among the children with moderate to severe asthma, 41.7% were appropriately treated with ICS and LABA, CSBA, or ICS with a long-term control alternative (leukotriene modifiers, cromolyn, or necrodomil). Forty-three percent of children with mild intermittent asthma were reported to have used inhaled corticosteroids in the month preceding their ED visit.

Table 14. Asthma treatment: Use of systemic corticosteroids

Corticosteroid use	*n*	Frequency
Ever used steroids given orally or by injection (%±95% CI)	113	81.9±6.4
Used steroids in 4-week period prior to ED visit (%±95% CI)	29*	25.7±8.1
Duration of oral steroid use in 4-week period prior to ED visit (%)		
1–2 days	10	35.7
3–5 days	10	35.7
6–10 days	5	17.9
>10 days	3	10.7
Days since oral steroids taken (%)		
Currently on steroids	10	35.7
1–5 days	8	28.6
6–10 days	2	7.1
11–20 days	2	7.1
21–30 days	6	21.4

Note: *One by injection.

When parents were asked directly if their child had ever taken systemic steroids, either orally or by injection, 81.9±6.4% said yes; 25.7±8.1% said they had taken steroids in the 4-week period before coming to the ED (Table 14). Ten children were on oral steroids when they were brought to the ED. Of the 59 patients were not currently taking ICS at the time of the ED visit, approximately one third (33.9%, n=20) reported that they had ever used ICS. Among the 17 patients who said they had taken ICS, the mean duration of a course of ICS was 210.4±168.1 days (range, 7–1095 days) and the mean time since patients were last on ICS was 434.5±204.5 days (range, 42–1460 days).

Most parents were able to get asthma prescriptions filled for their children (91.3±4.7%). Among the 12 children whose parents expressed difficulties in obtaining medication, reasons included financial and insurance problems, and pharmacy not having medication in stock.

Asthma management and control

Only 61.9±8.1% of children possessed a spacer, which is used in conjunction with a metered dose inhaler (Table 15). Among children with a spacer, 33% reported that they didn't always use it. The study restricted the question of whether they had a peak flow meter to children aged 7 and older. While 66.7±10.3% said they had a PFM, 46.3% admitted to using it only during an asthma attack.

Table 15. Asthma control and management

Use of asthma equipment	***n***	**Frequency**
Have a spacer (%±95% CI)	86	61.9±8.1
Use of spacer (%)		
Never	8	9.4
Rarely	5	5.9
Occasionally	8	9.4
Usually	7	8.2
Always	57	67.1
Have a peak flow monitor (PFM; ≥7 years) (%±95% CI)	54	66.7±10.3
Use of PFM (%)		
Rarely	9	16.7
<Once a week	3	5.6
1–3 times a week	7	13.0
4–6 times a week	2	3.7
Daily	8	14.8
Only during asthma attacks	25	46.3
Have asthma action plan (%±95% CI)	59	42.5±8.2
Had asthma education (%±95% CI)	103	74.1±7.3
Specific education (%)		
Asthma triggers	90	87.4
Medications & treatments	99	96.1
How to use inhaler or nebulizer	103	100
How to use a peak flow meter	60	58.3
Asthma attack strategy	87	84.5
How to use an asthma action plan	55	53.4

In response to the question 'Has a doctor or nurse ever given you a written asthma action plan,' 42.5±8.2% said they had been given one. Most children had received some asthma education (74.1±7.3%), and of those, all had been instructed on how to use an inhaler or a nebulizer. Almost all said they had been taught about medications

and treatments (96.1%), asthma triggers (87.4%), and asthma attack strategies (84.5%), but only 53.4% had received instruction on how to use an asthma action plan.

Asthma awareness

Patient knowledge of asthma was quite high: almost all agreed that controlling the inflammation that characterizes asthma can reduce symptoms (96.4%). Only 74.1% felt that most people with asthma can become free of symptoms with proper treatment; 91.9% did not think it was okay to stop taking medication if someone with asthma feels well.

Clinical data

Almost all children came directly to the ED from home (97.1%); three children were sent directly from their doctor's office and one was transferred from another urgent care center. The mean number of nebulizer treatments taken by patients in the 3 hours prior to arrival at the ED was 1.1±0.2.

Acute asthma severity

Two methods were used to measure the severity of the child's exacerbation upon presentation: PEF measurements taken pre and post treatment in the ED in children aged 7 and older (58/81), and a clinical evaluation of acute respiratory signs and symptoms. A respiratory therapist assessed the children for such signs and symptoms as coughing, breathlessness, wheezing, and work of breathing.

Predicted values of PEF were missing for 12 of the 58 children aged 7 and older. Exacerbations were categorized as severe if the pre-treatment PEF value was less than 60% of the predicted value, moderate if between 61 and 79%, and mild if ≥80%. Based on these criteria, 67.4% of children aged 7 and up (31/46) had a severe

exacerbation at the ED visit, 21.7% had a moderate attack, and 10.9% experienced a mild exacerbation (Table 16).

Table 16. Classification of acute asthma severity

Level of severity	*n*	% Patients
Acute severity (PEF based)[a] (n=46)		
Mild	5	10.9
Moderate	10	21.7
Severe	31	67.4
Acute severity (symptom based)[b] (n=139)		
Mild	51	36.7
Moderate	58	41.7
Severe	30	21.6
Acute severity (PEF or symptoms)[c] (n=139)		
Mild	45	32.4
Moderate	48	34.5
Severe	46	33.1

[a]Severity of exacerbation in children aged 7 years and older by PEF reading taken in the ED prior to administration of medication, according to NAEPP guidelines.
[b]Overall breathing severity during exacerbation determined by highest grade of severity among four breathing symptoms and frequency of coughing at presentation in ED. One child who had normal symptoms was categorized as mild.
[c]Acute severity determined by pre-treatment PEF readings for kids ≥7 and breathing symptoms for kids<7 and those missing PEF.

The highest level of severity among the five breathing signs and symptoms (breathlessness, presentation, breath sounds, work of breathing, and coughing) determined the aggregated clinical severity of breathing during the presenting exacerbation. Missing breathing data were coded as normal. Overall clinical severity classification based on breathing symptoms was much lower than that based on PEF values: 36.7%, mild (n=51); 41.7%, moderate (n=58); 21.6%, severe (n=30). Acute severity was also calculated by combining data on ED PEF values (pre-treatment) for children 7 years and older, and the severity data based on breathing symptoms for those children younger than 7 or who had missing PEF values (Table 16). This resulted in an acute severity distribution of one third mild, one third moderate, and one third severe.

Table 17 displays a comparison of chronic severity with acute severity in children ages 7 and older as determined by pre-treatment PEF measurements. No significant association was found between acute severity based on PEF values and chronic severity in children ≥7. No significant association was detected between chronic and acute severity in all children (Table 18).

Table 17. Comparison of chronic and acute severity in children ≥7

Chronic severity (%)	**Acute severity**[a]		
	Mild (n=5)	**Moderate** (n=10)	**Severe** (n=31)
MI (n=20)	1 (5.0)	3 (15.0)	16 (80.0)
MP (n=9)	1 (11.1)	4 (44.4)	4 (44.4)
Mod (n=6)	2 (33.3)	1 (16.7)	3 (50.0)
Sev (n=11)	1 (9.1)	2 (18.2)	8 (72.7)

[a]Acute severity by pre-treatment PEF readings. n=46.
No significant association, Mantel-Haenszel test, χ^2=0.63, p=0.4275.

Table 18. Comparison of chronic severity and acute severity in all children[a]

Chronic severity (%)	**Acute severity**[a]		
	Mild (n=45)	**Moderate** (n=48)	**Severe** (n=46)
MI (n=67)	21 (31.3)	23 (34.3)	23 (34.3)
MP (n=24)	7 (29.2)	12 (50.0)	5 (20.8)
Mod (n=20)	9 (45.0)	5 (25.0)	6 (30.0)
Sev (n=28)	8 (28.6)	8 (28.6)	12 (42.9)

[a]Acute severity determined by pre-treatment PEF values in children ≥7 and by severity of signs and symptoms on presentation in younger children and those missing PEF values. No significant association between chronic and acute severity, Mantel-Haenszel χ^2=0.07 (df=1), p=0.7975.

Emergency disposition

Approximately 84% of the children when discharged from emergency were able to return home. Twenty children were admitted to hospital (14.5%), while two children (1.5%) were admitted to intensive care.

Two-week follow-up results

The participation response at the 2-week follow-up interview was 96.4%. Five patients were unable to be contacted by telephone two weeks after they had left the ED. Just under half the patients (45.5±8.4%) had made follow-up appointments with their asthma care doctors by the time of the 2-week post ED visit interview (Table 19). The follow-up appointment occurred on average 5.7±1.3 days after the emergency visit for the 45 patients (33.6±8.0%) who were able to see their doctor by the time of the 2-week interview. Neither having made nor having had a follow-up appointment was associated with chronic asthma severity.

Table 19. Follow-up appointments and post-ED visit urgent treatment visits at the 2-week interview

Chronic severity (%)	**Made app't**		**Had app't**		**Relapses**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
MI (n=64)	29 (45.3)	35 (54.7)	23 (35.9)	41 (64.1)	3 (4.7)	61 (95.3)
MP (n=23)	13 (56.5)	10 (43.5)	8 (34.8)	15 (65.2)	3 (13.0)	20 (87.0)
Moderate (n=20)	8 (40.0)	12 (60.0)	5 (25.0)	15 (75.0)	1 (5.0)	19 (95.0)
Severe (n=27)	11 (40.7)	16 (59.3)	9 (33.3)	18 (66.7)	7 (25.9)	20 (74.1)
MH test X^2 p	0.26 0.6073		0.26 0.6085		6.66 **0.0099***	

Note: No significant trend between chronic severity and follow-up appointments.
*Significant trend between chronic severity and post index ED visit relapse by Mantel Haenszel (MH) test.

Fourteen patients required urgent medical treatment during the interval between the ED visit and the 2-week follow-up interview (10.5±5.2%). Twelve children experienced one relapse, one child had two, another had three urgent

care visits during this period. Relapses were significantly associated with increasing chronic asthma severity (p=0.0099, Mantel Haenszel χ^2=6.65); half of the relapses occurring in the group with severe persistent asthma.

Summary of measures of the NAEPP recommendations

Just over half of all patients (54.1%) had two or more regularly scheduled asthma care appointments with their RACP in the past year. Among patients aged 7 years and older, parents of two thirds of the patients reported that the children possessed a peak flow meter (66.7%), but close to one half of them used it only during asthma attacks (46.3%). Fifty-eight percent of patients with persistent asthma were reported to have used ICS in the 4 weeks leading up to the index ED visit. With respect to key items of asthma self-management, 42.5% had been given an asthma action plan and 74.1% had received asthma education. Among those who reported asthma education, all indicated that they had received training in how to use an inhaler or nebulizer. Ninety-four percent of the children who had an asthma action plan also reported having received education on how to use their plans. Slightly more than one quarter of all patients had consulted with an asthma specialist in the past year (26.6%). While 45.5% of all patients said they had made a follow-up appointment with their RACP, 32.4% had actually attended the appointment by the time of the 2-week interview after the ED visit. The mean time of the follow-up visit with the RACP after the ED visit was 5.7 days.

The proportion of participants for each of the seven NAEPP recommendations is shown in Table 20 by the level of chronic severity. Only two recommendations showed a statistically significant relationship with chronic

severity. The use of ICS increased significantly with severity, with the report of almost 70% of severe persistent patients taking ICS in the 4 weeks prior to the ED visit (Mantel-Haenszel χ^2=11.5, 1 df, p=0.0007). Children with increasing chronic severity were more likely to have seen an asthma specialist in the previous year (Mantel-Haenszel χ^2=4.74, p=0.0295), with 43% of subjects with severe persistent asthma having seen a specialist.

Table 20. Comparison of measures of NAEPP recommendations with chronic asthma severity

Chronic	**1** (n)		**2** (n)		**3** (n)		**4** (n)		**5** (n)		**6** (n)		**7** (n)	
severity	<2	≥2	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
(%)	(62)	(73)	(54)	(27)	(64)	(75)	(59)	(80)	(103)	(36)	(37)	(102)	(61)	(73)
MI	33	30	52	14	22	45	26	41	50	17	15	58	29	35
(n=67)	(52.4)	(47.6)	(61.1)	(38.9)	(32.8)	(67.2)	(38.8)	(61.2)	(74.6)	(25.4)	(22.4)	(86.6)	(45.3)	(54.7)
MP	11	13	11	4	11	13	11	13	19	5	3	18	13	10
(n=24)	(45.8)	(54.2)	(73.3)	(26.7)	(45.8)	(54.2)	(45.8)	(54.2)	(79.2)	(20.8)	(12.5)	(75.0)	(56.5)	(43.5)
Mod	5	15	8	5	12	8	9	11	15	5	7	16	8	12
(n=20)	(25.0)	(75.0)	(61.5)	(38.5)	(60.0)	(40.0)	(45.0)	(55.0)	(75.0)	(25.0)	(35.0)	(80.0)	(40.0)	(60.0)
Sev	13	15	13	4	19	9	13	15	19	9	12	19	11	16
(n=28)	(46.4)	(53.6)	(76.5)	(23.5)	(67.9)	(32.1)	(46.4)	(53.6)	(67.9)	(32.1)	(42.9)	(67.9)	(40.7)	(59.3)
MH test														
X^2	1.3		0.83		11.46		0.55		0.35		4.74		0.26	
p	0.2523		0.3600		**0.0007***		0.4585		0.5536		**0.0295***		0.6073	

Note: MI, mild intermittent chronic asthma; MP, mild persistent chronic asthma; Mod, moderate severity; Sev, severe severity; MH, Mantel Haenszel test. NAEPP recommendations: 1, regular asthma check-ups in the past year; 2, have a peak flow meter; 3, taking inhaled corticosteroids; 4, have an asthma action plan; 5, received asthma education; 6, saw an asthma specialist in past year; 7, made a follow-up visit with primary asthma care provider by the 2-week interview. *Significant trend.

Chapter 4

This study examines the consistency of asthma care and management with the *NAEPP Guidelines* among a cohort of children attending a midwestern hospital emergency department for their asthma. Studies of suboptimal asthma care, treatment, and management among ED patients, i.e., nonadherence to the NAEPP Guidelines, have been published previously; however, the focus has centered primarily on disparities of care in inner city, minority, poor, and managed care study populations (Crain et al. 1995; Ali and Osberg 1997; Vollmer et al. 1997; Legorreta et al. 1998; Doerschug et al. 1999; Rand et al. 2000). Participants in the Butterworth ED cohort study were 60% Caucasian and almost all had access to primary care and health care coverage. Yet despite the children having primary care providers, a substantial proportion reported asthma care and treatment that was inconsistent with the *NAEPP Guidelines*. Timeliness and quality of primary asthma care may be important predictors of asthma outcomes. Poor routine asthma care has been associated with higher emergency visit rates among inner-city African-American males with asthma (Murray et al. 1997).

The total number of asthma patients enrolled by the three EDs over the study period did not meet the desired sample size estimate of 385. The slow recruitment over the course of the enrollment period may have been due in part to a mild fall and winter in 2001, which brought in fewer asthma patients. Butterworth sees more asthma patients than the other two smaller hospitals and thus succeeded in enrolling its share of the study sample. The inability to recruit and enroll the required number of participants at Blodgett and Gerber was due to several factors. Study personnel were on site at

Butterworth Hospital, and thus were able to periodically survey the ED for potential participants and remind ED staff to call when an asthma patient came into the ED. Respiratory therapists at Blodgett and Gerber Hospitals had been expected to do the recruiting and enrollment, but lack of time while in the ED and their duties elsewhere in the hospital prevented them from recruiting patients. Lack of participation in the study on the part of the respiratory therapists stemmed from not only the extensive paperwork that was required for the recruitment and enrollment each patient (consent forms, screening log, clinical data form, ED visit interview), but also from unexpected barriers to reimbursing the respiratory therapists for their time and effort. The original intent of the study had planned to directly compensate respiratory therapists $50 for each patient they enrolled, but this incentive proposal was rejected by the hospital, which was in favor of having the funds paid directly into a general education fund. As an inducement to bolster enrollment at Blodgett and Gerber, a gift card was awarded quarterly to the respiratory therapist who enrolled the most patients. Butterworth Hospital's newly opened pediatric emergency department also caused a shift in ED use in that parents who reside in the Grand Rapids area preferred to take their sick children to Butterworth for pediatric emergency care rather than Blodgett Hospital, which does not have a pediatric ED. Although interviewer availability at Butterworth was not 24 hours a day, coverage of the ED was considered more than adequate with the arrangement of shift schedules among the three interviewers. There is a greater representation of patients who presented during the day and evening than of those who sought treatment at night, but this is unlikely to have biased the results in an appreciable way.

The study's research nurses were highly successful in contacting parents of patients at the 2-week follow-up interview, obtaining a 96.4% participation response. This proportion was higher than those reported in the cohort studies of Stevens et al. (85%, 2-week follow-up) and Butz et al. (88%, 8-week follow-up). Inability to contact patients for telephone follow-up was associated with age, gender, race, and socioeconomic status in a prospective cohort study of adult and pediatric ED patients with asthma of the Multicenter Airway Research Collaboration (Boudreaux et al. 2000). Boudreaux et al. reported that they were more successful at contacting pediatric patients (87%) than adults (71%) at the 2-week telephone follow-up. Techniques in conducting follow-up may also improve the chances of making contact: increasing the number of call attempts, asking for alternative numbers at the initial ED interview and best times to call.

Comparison of the Grand Rapids Children's Asthma Cohort Study with similar reports in the literature

The higher proportion of male patients with asthma than females in Butterworth ED study reflects the higher prevalence of asthma found among boys than girls (Gissler et al. 1999; Wieringa et al. 1999; Bjornson and Mitchell 2000). Butterworth patients (mean age 8.4 years) tended to be slightly older than the children in the ED studies previously reviewed (mean age range, 6.5–8.4 years) (Davidson et al. 1994; Dinkevich et al. 1998; Ferris et al. 2001; Scarfone et al. 2001; Stevens and Gorelick 2001). Just over half of the Butterworth ED children were diagnosed with asthma before the age of two (52%); this finding is similar to the ED study of Ferris et al. (2001), who reported that parents most often gave two years as the age of their child's diagnosis. Typical also of the high proportion of patients with Medicaid coverage in the ED articles reviewed in Chapter 1, almost half of the Butterworth study group had health coverage through Medicaid

(46.8%). In five out of seven ED studies, patients with Medicaid coverage comprised 50% or higher of the study population (Davidson et al. 1994; Crain et al. 1998; Dinkevich et al. 1998; Scarfone et al. 2001; Stevens and Gorelick 2001) (Table 5). African Americans comprised a much larger proportion of the ED study group (28.1%) than the 9% they represent of the Kent County population, as did Hispanic patients (15.1% of the ED cohort versus 7% of the Grand Rapids population) (US Census 2002). In seven of nine ED studies, the proportion of African Americans comprised a substantial proportion of the patient population, ranging from 54 to 100% of the pediatric asthma ED patients (Butz et al. 199; Friday et al. 1997; Crain et al. 1998; Ferris et al. 2001; Farber et al. 1998; Stevens and Gorelick 2001; Scarfone et al. 2001) (Table 5). The Hispanic patient component of these ED studies ranged from 13 to 61% (Davidson et al. 1994; Crain et al. 1998; Dinkevich et al. 1998; Ferris et al. 2001). Using data from the 1988 National Health Interview Survey, Halfon et al. found that race, education, family structure, place of residence, and usual source of routine care were among the strongest predictors for emergency department use; Medicaid coverage was not associated with the use of the emergency department for sick care, but rather other factors may account for the Medicaid effect (Halfon et al. 1996). At 60%, our study had a higher representation of Caucasian patients than the nine asthma ED studies reviewed, six of which took place in inner city hospitals (Table 5). The Butterworth ED study participants thus offer insight into NAEPP asthma guideline adherence in a group that one might expect to have better access to primary medical care and that may not face the same risks for asthma as children living in larger inner cities elsewhere.

Asthma care

Children who used emergency services at this Grand Rapids hospital had access to primary care, with 95% listing a provider and 85% of whom were reported to have provided regular asthma care. However, only just over half of the cohort had two or more regularly scheduled asthma care visits in the year prior to the ED visit (in accordance with the NAEPP guidelines). Slightly more than one quarter of the cohort (26.6%) saw an asthma specialist either for their primary asthma care or in addition to their regular asthma care. As expected, patients with more severe asthma were more likely to have seen an asthma specialist than those with milder asthma (severe asthma, 42.9% vs. mild intermittent, 22.4%; p=0.0295). When measures of asthma education, management, and control were compared, significant differences were found between those patients who had seen an asthma specialist in the past year and those who had not (education, 89.2% vs. 68.6%; asthma action plan, 73.0% vs. 31.4%; and ICS use, 70.3% vs. 37.3%). However, given the nature of the study design, it is not possible to discern the exact role of the specialist in contributing to these differences. (The decision to have a consultation with a specialist is driven, in part, by severity, which may also drive the use of these other measures.) There was, however, no difference between the two groups in occurrences of either relapse or post-ED care visits by the 2-week follow-up interview.

In several cross-sectional surveys of patients in managed care organizations, asthma care and treatment were more consistent with *NAEPP Guidelines* when patients were seen by asthma specialists rather than by generalists or primary care physicians (Legorreta et al. 1998; Diette et al. 2001; Wu et al. 2001). Integrating care by

an asthma specialist with that of a primary provider as part of a disease management program may be more easily implemented, and in fact encouraged, within managed care organizations (Vollmer et al. 1997). In a randomized study of health plan members aged 6–59 years, asthma care and treatment received after an ED visit was compared in one group of patients who were assigned to see an asthma specialist (n=149) with a control group who were assigned to a generalist physician (n=160) (Zeiger et al. 1991). In the intervention group, nighttime symptoms were reduced 75%, inhaled corticosteroid use was 3.6 times higher, and ED relapses fell by almost 50% by the 6-month follow-up. It should be noted that as this was an older study, the baseline rates in the generalist group were likely much lower than those of today. In a second randomized trial of 300 asthma patients aged 2–17 years recruited in an inner city pediatric ED to test the efficacy of a comprehensive asthma program, there were significantly fewer hospitalizations and ED visits in the group assigned to a specialty clinic (Harish et al. 2001). However, this study, which required patients to complete at least nine completed questionnaires, was plagued with poor follow-up. A potential bias may exist if patients who completed the study were different from those who dropped out.

Asthma severity

Controversy exists over the issue of how best to classify the asthma severity of patients. The *NAEPP Guidelines* categorize asthma severity according to the frequency of asthma symptoms and also to PEF or FEV1 readings; however, they do not expound upon a unified methodology for collecting data on asthma symptoms. Comparing the frequency distribution of asthma severity measured in our study with the selected ED studies previously reviewed is difficult, as various methods were used to determine

severity. Of the four articles reviewed that categorized severity, only the Scarfone article assessed chronic asthma severity by symptom frequency as per the NAEPP guidelines. Severity was classified as either persistent or mild intermittent based on the highest frequency of daytime or nighttime symptoms over a 3-month period prior to the ED visit (R. Scarfone, personal communication). In our study, looking at symptoms over a shorter period (1 month), we also included the frequency of restricted activities into the chronic severity construct, as we were concerned that basing a patient's overall severity on just recent daytime or nighttime symptoms may result in an underestimation. (Colice et al. 1999; Fuhlbrigge et al. 2002) Severe nighttime symptoms and restricted activities of the Butterworth children contributed more to the overall severe category of chronic severity than did daytime symptoms (Fig. 3). Nevertheless, in Scarfone's survey of children at an urban pediatric ED, there was a higher proportion of persistent asthma: 36% mild intermittent/64% persistent severity versus our 48% mild intermittent/52% persistent.

In another study by Warman, asthma severity was measured by applying the NAEPP daytime and nighttime symptom criteria only (Warman et al. 2001). This study population of children, who had visited an inner city medical center, had a high proportion with persistent asthma (83%), yet only 35% were on daily anti-inflammatories. Children who were classified with moderate to severe asthma had significantly more ED visits in the previous 6 months than children with mild intermittent or mild persistent asthma. There was a trend towards more hospitalizations in the past 12 months with increasing asthma severity, but this was not significant (Warman et al. 2001). By contrast, among the Butterworth children (31% of whom had been

hospitalized at least once in the past year), no significant relationship was detected between chronic asthma severity and hospitalizations or ED visits in the past year (Tables 12B–12C).

Initially our severity aggregate also factored in the number of exacerbations patients had experienced in the month before the ED visit, but it did not greatly alter the classification of severity. No lung function data, such as PEF, on patients were available for the month preceding the ED visit.

It is possible that the level of severity assigned to the Butterworth study participants may be an underestimation of their actual underlying severity, given that the NAEPP Guidelines for severity classification apply to clinical features in absence of asthma medication. In the 4-week pre-ED visit period during which chronic severity was assessed, 61% of the children were reported to have used at least one long-acting control medication. The assigned severity level of the Butterworth children more accurately reflects the degree of their asthma control. Almost half of the study group (48.2%) was classified as having mild intermittent asthma during this time period. Nevertheless, despite the limitations of our severity construct, trends in several measures suggest that this aggregate is capturing something.

The determination of the underlying asthma severity by the physician is the basis for determining asthma care and treatment (Wolfenden et al. 2003). A physician may be unaware of a patient's recent asthma symptoms, owing to infrequent patient contact (Wolfenden et al. 2003). When questioned, patients with asthma may downplay their symptoms, resulting in an underestimation by the physician and subsequent undertreatment. An incorrect or outdated clinical assessment of severity can result in

inappropriately prescribed asthma medications and dosages (Meijer et al. 1997; Wolfenden et al. 2003) and may contribute to poor adherence to NAEPP Guidelines (Halterman et al. 2002). The potential for underestimation of severity underscores the importance of periodic asthma checkups and for patients to maintain a regular dialogue with their RACP, and to have a valid, repeatable, consistent, and practical method for assessing severity. Children who had been seen by their primary physicians in the past 6 months were more likely to have been correctly classified in a study by Halterman et al., who considered the parents' description of asthma symptoms as the gold standard measure of their child's severity (Halterman et al. 2002).

Peak flow monitoring is useful for the assessment of the severity of exacerbations (NAEPP 1997). Acute severity measured by pre-treatment PEF identified 31 Butterworth patients aged 7 and older as severe, whereas only 12 of these patients were assigned to the severe category when acute severity was measured by the clinical evaluation of respiratory signs and symptoms, suggesting that symptom-based measures may underestimate severity. The Colice study found poor correlation between asthma severity determined by the symptom-based NAEPP criteria and lung function measures (Colice et al. 1999).

As anticipated, our analysis showed no correlation between chronic asthma severity in the 4 weeks prior to the ED visit and acute severity measured at the ED. The underlying chronic pathology of asthma is thought to differ from the acute exacerbations of bronchoconstriction and airflow limitation caused by a variety of asthma triggers.

More research and guidance from the NAEPP is needed to correctly classify asthma severity. Categorizing asthma severity based on hospitalization and ED visits,

as done in the Crain ED study and two Medicaid studies on asthma care received by children with asthma, is problematic in that it captures issues other than just the severity of asthma symptoms, such as parent perception of disease, access to care, and adherence to appropriate therapy (Crain et al. 1998; Bauchner 2000; Apter et al. 2001; Shields et al. 2002). As it stands now, measuring asthma severity is subject to wide interpretation of the NAEPP Guidelines. A validated method for the categorization of asthma severity would be a welcome tool for both clinicians and asthma researchers (Colice et al. 1999).

Asthma control and management

The July 2002 *NAEPP Guidelines* recommend ICS and long-acting β-agonists (LABA), for the treatment of patients with moderate and severe asthma; patients with severe asthma may require oral steroids in addition, if needed (NAEPP 2002). One noticeable difference from the nine ED articles reviewed has been the higher use of ICS reported by the Butterworth patients (46.0% overall, 64.6% among those with moderate/severe asthma, and 70.3% of those who saw an asthma specialist) and less reliance on cromolyn/necrodomil (3.6%, n=5) and theophylline (0.7%, n=1), as these medications have been substituted by more effective asthma drugs (Barnes 1997). Although the NAEPP does not recommend ICS for mild intermittent asthma, 32.8% of children so classified reported ICS use. This suggests that either these children experience episodic acute attacks or their severity classification in reality reflects how well their medication is controlling their symptoms.

Only 22.3% of patients were taking ICS and LABA either as two separate medications or as one combination therapy. Almost 97% of the Butterworth patients on

ICS and LABA also reported that they used short-acting β-agonists (albuterol) for quick relief. LABA provide effective bronchodilation but have no anti-inflammatory effects and so should be used in combination with ICS to effectively control asthma symptoms (Barnes 1997). None of the nine reviewed ED studies had data about LABA use. Salmeterol (an LABA) was approved for market in 1994 and was listed as an alternative medication in the *1997 Guidelines*. Since that time the NAEPP has gathered stronger evidence from numerous clinical trials that the combination of LABA and ICS improves lung function and overall asthma control and reduces the number of severe asthma exacerbations among moderate to severe asthmatics (Aronson et al. 2001; NAEPP 2002), although it should be noted that many of these trials were sponsored by pharmaceutical companies that manufacture a combination therapy inhaler (Glaxo Wellcome and AstraZeneca). While this study ended two months after the publication of the July 2002 NAEPP update, our LABA data provide a baseline from which to track progress in the use of LABA among moderate and severe asthma patients. There is a need to promote this latest recommendation of combination therapy for moderate to severe asthma patients among primary asthma care physicians.

Age of the child has been an important consideration when prescribing ICS, in particular, because of potential side effects such as growth, bone density, ocular toxicity and suppression of the hypothalamic-pituitary-adrenal axis (Barnes 1995; NAEPP 2002). Despite the lack of studies comparing corticosteroids and other long-term medication in children less than 5 years of age, the NAEPP advocates that they be treated with low-dose ICS. Our results showed that 52.8±16.3% of the Butterworth ED children under 5 were prescribed ICS. From a 1997 primary physicians' survey, inhaled

corticosteroids were prescribed by 60.5% of physicians for patients under 5 years of age and by 95.7% of physicians for patients 5 years and older (Grant et al. 1999).

After ICS, use of leukotriene modifiers was the second most commonly reported long-term control medication (17.3% of the patients). Leukotriene modifiers are considered an alternative medication to LABA and can also be used in combination with ICS for moderate and mild persistent asthma. (NAEPP 2002) In our study, 18.8% of children on ICS were also reported taking leukotriene modifiers. Scarfone did not include data on leukotriene antagonists, as so few patients were taking these medications (Scarfone et al. 2001). Use of the combination inhaler (LABA and ICS) is thought to improve compliance, give better control of asthma, and be preferred among patients (Barnes and Connor 1995); in our study, parents indicated that 14.4% of the children were taking this particular medication.

Fifteen of the eighteen children who were not taking any quick relief or long-acting medication had mild intermittent asthma. Of the 48 children with chronic moderate to severe asthma, we estimate that 18.8% were undertreated, as they were not taking long-acting control medication of any kind. Another 40% of moderate to severe asthma patients were likely undertreated for their level of severity, as they were taking either ICS or long-acting control medication, such as leukotriene modifiers, LABA, or cromolyn/necrodomil, but without the benefit of ICS. Necrodomil has some anti-inflammatory properties, but ICS are considered more effective anti-inflammatories.

Possession of the appropriate asthma equipment is essential to good asthma control practices. Spacers facilitate the delivery of medication to the lungs and make metered dose inhalers easier for children to use (Kemp and Kemp 2001). Almost 40%

of the Butterworth children did not have a spacer and among those who did, a third did not always use it with their inhaler. (Our questionnaire did not ask directly if patients had an inhaler. Although based on the types of inhaler medication the parents reported, the proportion of children using inhalers must have been over 80%.) Among those children in Crain's clinic and ED study who had been prescribed inhaler medication, 39.5% had a spacer (Crain et al. 1998). In Scarfone's survey, 80% of the children had an inhaler; but of those who used it regularly, 48% did not routinely use a spacer with it (Scarfone et al. 2001).

Between 13.7 and 45% of patients had been prescribed a peak flow meter in the earlier studies by Crain and Scarfone, but two thirds of the Scarfone patients did not use their PFMs (Crain et al. 1998; Scarfone et al. 2001). It is encouraging that the ownership of PFM appears to be increasing over time, as our study found that 67% of patients aged 7 and over had a PFM. However, almost half of these children (46.3%) stated they used their PFMs only during attacks and therefore not on a regular basis. Ownership of PFMs was more prevalent among Butterworth ED children with moderate to severe asthma than among those with mild intermittent asthma (70% vs. 61.1%), although this difference was not significant.

A high proportion of children visiting EDs and medical centers for urgent asthma do not have asthma action plans. Evidence suggests the use of asthma action plans can reduce hospitalizations and ED visits (Ordonez et al. 1998; Meurer et al. 2000). In our study, 57.5% of the Butterworth ED patients reported that they did not have an asthma action plan. This finding is fairly consistent regardless of the study. Warman's telephone survey of parents of 2- to 12-year-olds, who had been hospitalized for asthma in the

past year at an inner city New York hospital, reported that only 51% had a written asthma action plan (Warman et al. 1999). In a survey of 318 parents of patients (5–17 years) who were members of two managed care organizations, 49% had written instructions for dealing with an exacerbation (Diette et al. 2001*a*). Many Chicago-area primary care physicians in a 1997 survey stated that they did not give written asthma treatment plans to their asthma patients; they wrote up plans for only about half of their moderate to severe asthma patients (Grant et al. 1999). It is not known whether the doctors were unaware that this was recommended in the *Guidelines* or whether time constraints or other factors were to blame.

Asthma education

In general, asthma education programs that teach self-management skills to patients are more successful than those that are strictly knowledge-based (Kennedy et al. 2003). Providing information alone has had little impact on improved asthma outcomes (Bernard-Bonnin et al. 1995; Gibson et al. 2001). In a meta-analysis of 32 eligible trials, asthma self-management education programs for children that taught strategies related to prevention and attack management resulted in improved physiological function, decreased asthma morbidity, and reduced health care utilization (Wolf et al. 2003). The emphasis on patient education reflects the importance of the patient's role in managing his/her asthma symptoms.

Unfortunately, we have little information on the scope of asthma education that the Butterworth ED patients had received, other than the topics the respiratory therapist typically covers during an ED visit and what the parents reported. Without a comparison group, our data on education are difficult to interpret.

The NAEPP advocates asthma education not only for the patients but also for the physicians. Physicians who received asthma education as part of a clinical trial were more likely to prescribe ICS to new pediatric patients, and to give written instructions to patients on how to adjust medications and modify therapy when symptoms change (Clark et al. 1998; Clark et al. 2000). Long-term outcomes included fewer hospitalizations for asthma and, among those who had higher levels of emergency use, fewer subsequent ED visits (Clark et al. 2000). However, this study suffered a 68% attrition rate; in addition, children with a history of higher hospital use were more likely to have been in the intervention arm (physicians receiving education).

It should be noted that the next study being conducted in Grand Rapids involves an educational intervention on physicians.

Follow-up appointments

Approximately one third of the Butterworth ED patients reported that they had gone for a post-ED checkup when contacted two weeks after the ED visit, while an additional 13% had pending appointments. Patient noncompliance with follow-up appointments is well documented and may be responsible for continued disease activity (Scarfone et al. 1996; Leickly et al. 1998). Noncompliance with instructions to go for a follow-up visit either with a PCP or at the ED ranges from 33 to 75% (Scarfone et al. 1996; Thomas 1996; Leickly et al. 1998; Oregon Department of Human Services 2002). In a multisite longitudinal study on barriers to adherence, parents were asked whether a follow-up appointment had been made for their child before they left the ED after treatment for acute asthma or whether they were advised to make one (Leickly et al. 1998). When a follow-up appointment was scheduled for the patient before discharge from the ED,

69% of 3- to 9-year olds kept their appointments; when their parents were instructed to make a follow-up appointment, compliance was 60%; and when an appointment was not made at discharge nor were parents advised to make an appointment, only 25% of parents took their children in for follow-up care (Leickly et al. 1998). Patients may face several barriers to follow-up care, for example, they may not be able to get through to their RACP by phone to book a follow-up visit (Leickly et al. 1998). Other factors associated with noncompliance with follow-up instructions included improved health of child, parents' perception of the degree of child's illness, parents younger than 21 years of age, parent was working or too busy, and parent had no means of transportation (Scarfone et al. 1996; Leickly et al. 1998).

Post ED visit relapses

Our relapse rate of 10.5±5.2% compares well with the 10% incidence of relapse reported in two cohort studies: one, a prospective inception cohort study of children, aged 2–17 years, conducted in 44 EDs (Emerman et al. 2001); and the second, a one-year retrospective chart-review study of 422 patients aged 5 months to 17 years who had attended an emergency department for asthma (Barnett and Oberklaid 1991). In an older study of a prospective cohort followed after discharge from a children's hospital emergency department reported a 31% relapse rate 10 days after discharge (Ducharme and Kramer 1993).

The relapse rate at the 2-week post ED interview significantly increased with asthma severity; of interest will be whether this trend is observed in results from the 6-month follow-up interview.

The *NAEPP Guidelines* advocate ICS for persistent asthma and oral steroids for patients upon discharge from the ED after an acute asthma attack (NAEPP 1997). A recent meta-analysis examined whether prescribing inhaled corticosteroids at discharge would reduce the likelihood of return visits to the ED for acute asthma (Edmonds et al. 2003). Three random clinical trials were included in this meta-analysis, involving a total of 909 patients (ages 12–60), and compared the treatment at discharge of ICS plus oral corticosteroids (OC) with OC alone (Edmonds et al. 2003). Although there was a trend in favor of ICS, the difference in relapse after ED discharge was not significant at 7–10 day follow-up (odds ratio (OR)= 0.72; 95% CI, 0.48–1.10) nor at 20–24 day follow-up (OR=0.68; 95% CI, 0.46–1.02). Another meta-analysis of seven random clinical trials of patients (four of children, three of adults) discharged after an ED visit for acute asthma compared post ED prescription of ICS versus OC (Edmonds et al. 2003). Again, no significant differences between treatments were found in asthma relapse at either 7–10 day (OR=1.0; 95%CI, 0.66–1.52) or 16–21 day follow-up (OR=1.26; 95% CI, 0.80–1.99). The findings were deemed inconclusive as all seven studies excluded patients with severe asthma, the sample sizes were considered inadequate to prove equivalence between the treatments, and there was heterogeneity among the studies in several secondary outcomes (β-agonist use, symptoms, and quality of life). One study that did show a positive result, a random clinical trial that was included in the three trial meta-analysis, demonstrated a 48% reduction in asthma relapse after discharge for the ICS group (12.8%) compared with the identical placebo (24.5%) (Rowe et al. 1999). More research is required to explore whether ICS added to OC at discharge clearly benefits patients and whether a higher dose of ICS, as was used in the Rowe trial,

might prove more beneficial than the lower doses reported in the other two studies. Further investigation should also include trials involving young children, as none of the above mentioned trials involved participants younger than 12 years.

Adherence to the NAEPP Guidelines: the gold standard?

While the *Guidelines* have been promoted as the standard in asthma treatment and management, it remains to be seen whether adhering to the recommendations will improve asthma-related outcomes. Evidence has been inconsistent in showing that variations in asthma care and home management correspond with changes in health care services, mortality rates, or reduced morbidity (Crain et al. 1995). The *Guidelines* have been formulated by a panel of asthma specialists backed primarily by an extensive literature review and evidence from existing clinical trials. However, the *Guidelines* have shifted attention from traditional medical treatment to a broader scope of asthma management that emphasizes a greater role of the patient in controlling their disease. With an increased role for patients in monitoring their disease, concern arises as to whether they will be able to sustain the level of compliance necessary to keep their asthma in check, e.g., taking PEF measurements several times a day, keeping track of how much medication they are taking and when, especially children. Patients need to be able to recognize when in the course of their disease they may step-down or step-up certain components of their plan. It is critical for their well-being that patients work along with their care providers to appropriately monitor and manage their disease. In absence of any other gold standard, the NAEPP Guidelines offer a standard for consistency or asthma care and treatment. The establishment of these recommendations has provided a scientific basis on which to form testable hypotheses

for additional research that will perhaps delineate which components of the asthma management programs are essential as well as time- and cost-effective (Meijer et al. 1997).

This study is the first to our knowledge to compare self-reported asthma patient care and management with key NAEPP recommendations in Michigan. Consequently it is not possible to gauge whether there has been an improvement in these measures in the study population since the inception of the *NAEPP Guidelines*. However, comparison of our study with similar studies of ED patients suggests that there has been some progress in several measures of NAEPP recommendations in patient care. In particular, we note the more widespread use of ICS and possession of peak flow meters as well as the report of asthma education among the Butterworth patients. Not all recommendations, however, show evidence of integration into asthma care practices within the local asthma medical community. Notably, the majority of these children had not been given an action asthma plan.

Several measures are expected to be dependent upon the level of chronic severity. However, patients with severe asthma did not have significantly more checkups in the past year than patients with mild disease, although three quarters of patients with moderate persistent asthma indicated that they had made at least two regular checkups. Apart from a difference between mild intermittent and severe patients, we did not detect a significant trend among the Butterworth patients in ownership of a PFM based on their severity, despite the fact that long-term monitoring with a PFM is recommended for patients who have moderate to severe persistent asthma. The increasing use of ICS with asthma severity (Table 13B) suggests that ICS are being

prescribed in accordance with the *NAEPP Guidelines*. One third of mild intermittent asthma patients were also taking ICS, but we have no way of knowing whether these patients were prescribed medications inappropriate for mild asthma symptoms or their level of severity is indicative of controlled asthma.

Patients at discharge were instructed by the ED staff to see their RACP for follow-up. Failure on the part of the patients to do so did not appear related to patient asthma severity. It is not known whether parents did not comprehend the importance of obtaining follow-up medical attention for their child or other reasons prevailed for not making the post-ED RACP appointment, as previously discussed.

Despite some progress towards following the NAEPP recommendations compared with the older ED studies we have reviewed, the data from our study reveal several gaps in the continuity of care reportedly received by the Butterworth ED patients and in the ability of patients and parents of children with asthma to self-manage their disease. These shortcomings do not appear to be related to patient barriers to access to care, as almost all of these patients said they had health care coverage and a RACP. Two explanations for these gaps exist: failure of the RACP/regular asthma care program to fully educate the patient and family with respect to the tools, information, and self-management skills required to manage asthma as a chronic disease; and (or) inability of patients to adhere to their asthma management program. Barriers to adherence may lie not only with the parent's lack of understanding of what is expected in terms of providing optimal asthma care for their children, but also in the failure on the part of RACPs to accept or incorporate the recommendations into their practice and (or) in the

quality of the asthma care and education delivered to the patients by their provider (Leickly et al. 1998).

We have seen that while most primary care physicians have read the NAEPP Guidelines, integrating the recommendations into their clinical practice has not been universal or immediate. There are probably many obstacles to doing so of which we are unaware.

Managing a chronic disease requires continual maintenance and problem-solving skills that many parents, especially young parents, may feel ill-equipped to handle. Imparting such skills to parents and people coping with asthma is part of a collaborative care partnership with primary care physicians that fosters in patients the knowledge, ability, and confidence to effectively cope with their disease (Bodenheimer et al. 2002).

Limitations of the study

Low enrollment changed the planned analysis for this cohort. While the resulting sample size is sufficient for overall measures of proportions, it limits subgroup analyses and what can be concluded from a number of parameters in this analysis. For example, with a larger sample (and smaller confidence interval), we would feel more certain that 9.4% truly represented that proportion of children reporting the use of LABA.

An additional NAEPP recommendation addresses the control of allergens that trigger asthma exacerbation. Our study did not collect information on asthma triggers or environmental allergens, e.g., no data on smoking in the house. Additional information on asthma triggers and allergies might shed light on the distribution of asthma symptoms and the transient nature of chronic severity.

Because patient recall tends to diminish over time, accounts of events beyond a 2- to 4-week recall period may not be accurate (NAEPP 1997). It was not possible to confirm information provided by patients about hospital utilization and medical appointments in the past year. Lack of parental report of an item is not necessarily the result of poor parental recall, but may be due to the doctor not having performed it (Dinkevich et al. 1998). Parents or guardians with whom the interviews were conducted may not have been the child's primary caregiver, and consequently they may not have first-hand knowledge of the child's asthma.

No information was collected about the dose of ICS the children were taking in the 4 weeks prior to the ED visit. This information would have helped to determine adherence to *NAEPP Guidelines* with respect to severity.

The possibility exists for incorrect classification of medications patients were taking. We do know that at least one drug may have been incorrectly coded, e.g., there are two preparations of Proventil (albuterol), one is for extended release, i.e., a long-acting β-agonist, and it is also sold as a quick-relief inhalation medication. Three children reported taking Proventil and were classified as taking a short-acting β-agonist, but it is not possible to know which version of Proventil they were taking.

Finally, without a control group, we do not know how representative the findings of this cohort study are of all children with asthma who present at EDs or at other urgent care centers. In an emergency department setting, finding an inherent control group for a study investigating aspects of asthma care and management would be problematic, and in fact, has not been done to our knowledge in other ED-based studies. The conclusions about our results are certainly applicable to patients with primary care

access who use the ED and provide new information that will be useful in future research endeavors.

Conclusions and future directions

This study establishes a baseline characterization of pediatric asthma patients who utilize emergency services for asthma treatment in the Grand Rapids area. The results presented provide region-specific data on aspects of primary care patient self-management for asthma that could be used for the development of educational programs or interventions targeted to reduce gaps or fill voids in the delivery of asthma care and management information. The following are suggested for future action:

1. Advocate the necessity of asthma action plans for all asthma patients among managed care organizations and primary care physicians. Promote among physicians the need to develop the plans with the patients, provide education about aspects of the plan, and periodically review with patients what steps to follow when they experience an asthma attack.

2. Increase RACP awareness of patient's asthma severity through increased contact (frequent asthma care visits, telephone assistance). Techniques, such as the use of diary cards by patients, may capture more relevant symptom data useful in determining asthma severity. To promote continuity of care, it may be helpful to schedule the next visit at the time of the present one.

3. Link an ED visit with a follow-up RACP visit. As research has shown that patients are more likely to attend follow-up appointments when they are made before the patient has left the ED, exploring ways to accomplish this are recommended. Barriers to booking follow-up appointments for patients include possible lack of ED staff for this function and

inability to contact primary care offices during evening, nighttime and weekends. One method to circumvent this problem might be to electronically contact the patient's primary care provider to prompt the PCP office to make an appointment with the patient.

4. Foster a collaborative care partnership among RACP, asthma specialist, and patient to facilitate asthma care.

5. Promote awareness among primary asthma care physicians that combination therapy of ICS and LABA is now recommended for moderate to severe asthma patients.

6. Survey primary care health professionals in the Grand Rapids area to assess local level of knowledge of the *NAEPP Guidelines* and updates, to determine any barriers in delivering the recommended care and asthma education, and to investigate under what circumstances physicians refer asthma patients to asthma specialists.

7. Future studies should include questions about allergies and environmental triggers of asthma.

8. Further research in children is required to explore whether prescription of ICS at discharge from the ED may reduce the incidence of asthma relapse.

9. Design an epidemiological cohort study to investigate whether adherence to the NAEPP recommendations results in improved asthma-related outcomes, such as timely follow-up visits, fewer hospitalizations, ED and urgent visits, regularly scheduled asthma care, and appropriate use of asthma medication for the patient's level of chronic severity. A baseline evaluation of asthma patients at primary care clinics would identify those patients who follow the recommendations (exposed group) and those who do not (control group). Of interest would be to identify which recommendations have a stronger influence than others on the outcomes.

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