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BASELINE CHARACTERISTICS AND RISK FACTORS FOR
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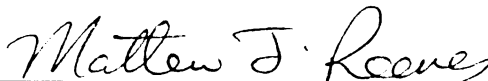

SAINAN WEI

has been accepted towards fulfillment
of the requirements for the

Master of Science	degree in	Epidemiology

Matthew J. Reeves

Major Professor's Signature

5/28/04

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EMERGENCY DEPARTMENT ASTHMA VISITS IN ADULTS: BASELINE
CHARACTERISTICS AND RISK FACTORS FOR ASTHMA RELAPSE

By

Sainan Wei

A THESIS

Submitted to
Michigan State University
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Abstract

EMERGENCY DEPARTMENT ASTHMA VISITS IN ADULTS: BASELINE CHARACTERISTICS AND RISK FACTORS FOR ASTHMA RELAPSE

By

Sainan Wei

Asthma is a chronic illness that has been increasing in prevalence in the United States since 1980. Identifying patients with a high risk of relapse would be useful in designing more effective pharmacotherapeutic, educational, and environmental self-monitoring interventional programs.

Of the 172 enrolled patients, 138 patients had follow up information at 26 weeks after their ED visit. The cumulative incidence of relapse up to 26 weeks was 30%. The frequency of prior hospitalization in the last 12 months was the only risk factor identified. In a model that included age, gender, race, and asthma severity, the patients that had 1 prior hospitalization in the last 12 months had hazard ratio of 3.1 (95% CI 1.1-8.6). The hazard ratio increased to 3.3 (95% CI 1.4-7.8) for patients that had more than 2 hospitalizations in the last 12 months. When severity was excluded from the model, the hazard ratios were 2.5 (95% CI 1.0-6.7) and 4.1 (95% CI 1.8-9.2) in patients who had 1 or 2 or more hospitalizations in the last 12 months, respectively.

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I am most grateful to Dr. Rachel Fisher for suggesting the idea of pursuing Genetic Epidemiology while I was a doctoral student in the genetics program, and for all her encouragement, patience, and instruction on my journey into the scientific research world.

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ABBREVIATIONS

AMP	Asthma Management Plan
COPD	Chronic obstructive pulmonary disease
CSBA	Combined SABA and ICS
ED	Emergency Department
ER	Emergency Room
HIV	Human Immunodeficiency Virus
ICS	Inhaled Corticosteroid
LABA	Long-acting beta$_2$-agnonist
LM	Leukotriene Modifier
MARC	Multicenter Asthma Research Collaboration
NAEPP	The National Asthma Education and Prevention Program
NHLBI	National Heart Lung and Blood Institute
PCP	Primary Care Provider
PEF	Peak expiratory flow
PFM	Peak Flow Meter
RAD	Reactive Airway Disease
SABA	Short-acting beta$_2$-agnonist
SOB	Shortness of Breath

Chapter One: Background

Emergency department visits for asthma

Emergency departments (ED's) play a crucial role in the management of asthma. Frequently, they are main source of medical care for some populations, such as those with low income, low education, and minorities. Use of emergency departments by persons with asthma is one of the key manifestations of asthma morbidity in the United States and is an important public health concern (*Mannino, 1998*). Each year, despite a wide array of effective asthma treatments, people with asthma make approximately 1.8 million visits to emergency departments, resulting in direct medical costs in excess of $250 million dollars. ED visits for asthma are believed by some to indicate a failure of available primary care, and are regarded as mostly preventable (*National Institutes of Health .1997; National Heart, lung, and Blood Institute. 1995; Dales et al. 1995*).

The overall age-adjusted rate of emergency room visits for asthma increased 11.9 per 10,000 between 1992 and 1995 (http://www.nhlbi.gov/health/porf/lung/asthma). During 1995, asthma was the cause of more than 1.5 million emergency department visits *(National Heart, Lung and Blood Institute, 1999)*. There were an estimated 1.8 million ED visits for asthma in 2000, or 67 per 10,000 people. Adults 18 years and over had 54 ED visits per 10,000. There are large racial differences especially blacks versus whites in the use of ED for asthma (*Weiss et al. 1992; Burt et al. 1994*). The ED

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visit rate for blacks was 125% higher than that for whites in a study by CDC. This same study also reported that the ED visit rate in females was about 30% higher than for males (*CDC, 2002; MMWR, 2003*)

Asthma relapse following an ED visit

A thorough literature search was conducted using keywords 'adult asthma', 'observational study', 'emergency department visit' in MEDLINE and PubMed for publications between 1990 to 2002, 27 references were identified, 8 articles were finally selected in terms of relevance to this study. Table 1 lists these studies.

A significant portion of patients treated in Emergency Department (ED) for acute asthma exacerbation suffer a relapse and require repeat ED visits, hospitalization or other urgent medical treatment. One measure of the inappropriateness of ED management has been the proportion of treated patients who had relapse, which is defined as the unscheduled return to an ED or physician's office for increasing asthma symptoms shortly after the ED visit (*Ducharme, et al. 1993; Rose, et al. 1984; Centor et al. 1984; Emerman, et al. 1995*). The rates of relapse after ED visit for acute asthma reported in previous studies have varied, for example, 25.3% relapse rate within 3 weeks of discharge in a cohort study of 104 adult asthma patients (*Emerman et al. 1995*); six percent (6%) within 7 days, eight percent (8%) by 10 days, and forty-five percent (45%) by 8 weeks in a cohort study of 284 adult asthmatics (*McCarren et al. 1998*); twenty-one percent (21%)

in a cohort study of 641 adult asthmatic patients and seventeen percent (17%) relapse rates were reported within 14 days in other cohort study of 223 patients from Emerman's group (*Emerman et al. 1998; Emerman et al. 1999*). Identifying patients with a high risk of relapse would be useful in designing more effective pharmacotherapeutic, educational, and environmental self-monitoring intervention programs.

Attempts to identify patients at high risk of relapse by analyzing various factors have produced conflicting results. Clinical features such as pulse rate, respiratory rate, peak expiratory flow rate, moderate to severe dyspnea and wheezing in a multi-factorial analysis were reported to predict relapse (*Fischl, et al. 1981*) but could not be validated in subsequent studies (*Rose, et al. 1984; Centor et al. 1984*). Several investigators have found that features such as frequent ED visits, hospitalizations, and medication usage predicted relapse (*Ducharme, et al. 1993; Emerman, et al. 1995; Newcomb, et al. 1986; Li, et al. 1995*). It is understandable that studies addressing heterogeneous groups of patients may have conflicting results. These investigations may be more a reflection of different level of disease presentation on a population basis (Table 1).

Table 1. Previous studies on asthma relapse following ED visit

Author	Year	N	ED description	Design	Outcome	Conclusion
Emerman CL et al	1995	104 adult asthma patients	University-affiliated county hospital ED	Prospective cohort	Unscheduled clinic or ED visit for asthma, 21 days follow-up after ED discharge	Relapse rate was 25.3%. Greater number of recent ED visits was associated with relapse
Hanania NA et al	1997	120 asthma patients at aged 18-65 yrs	Hospital ED and asthma center at the Toronto Hospital	Prospective cohort	Dependence on ED care vs. employing self-management plans in a ambulatory setting	Patients with lower income, less knowledge about asthma and its management, live alone, and have resided at their current address for less time more depend on ED asthma care
McCarren M et al	1998	284 adult asthma patients	County hospital	Prospective cohort	Unscheduled first ED visit for increasing asthma symptom by 8 weeks	Three or more visits to an ED in last 6 months; difficulty performing work or activities as a result of physical health in the 4 weeks prior; discontinuing hospital-based treatment for the exacerbation within 24 hours without having achieved a peak expiratory flow rate of at least 50% of predicted were risk factors for relapse
Emerman CL et al.	1998	223 asthma patients at aged 18-50	Large, county-owned hospital ED	Prospective cohort	Repeated ED or physician visit within 2 weeks after ED visit	Relapse rate was 21%. Lack of an identifiable PCP, and inability to obtain discharge medications were risk factors for relapse

Author	Year	N	ED description	Design	Outcome	Conclusion
Emerman CL et al	1999	641 asthma patients at age of 18 – 54 yrs	MARC, 36 ED's in 18 states	Prospective cohort study	Admission to hospital or ED visit 2 weeks follow-up after ED discharge	Relapse rate was 17%. Numerous asthma-related ED and urgent clinic visit within the past year; more outpatients asthma medications, including home nebulizers; longer duration of symptoms were the risk factors
Adams RJ et al	2000	293 asthma patients who are able to give consent	2 teaching hospital ED's in South Australia	Longitudinal observational study	Admission to hospital repeat ED visit over a 12 month period	Risk factors were not possessing a written asthma action plan, avoidance coping, and attitudes to self-management
Ford JG et al	2001	375 low-income and minority aged 26-54 yrs	Hospital ED and outpatient chest clinic	Cross-sectional survey	Frequent ED use	Asthma severity was the strongest predictor of frequent ED use
Weber EJ et al	2002	1805 adult asthma patients	64 ED's in US and Canada	Prospective multicenter cohort study	Hospital admission within 2 weeks follow-up after ED visit	Risk factors were: final peak flow, female sex, nonwhite race, severity of chronic illness, and severity of exacerbation

Some researchers have found a positive association between pulmonary function testing results and subsequent relapse (*Kelsen, et al. 1978; Fischl, et al. 1981; Chapman, et al. 1991; Nowak, et al. 1982*), whereas other studies have found no such association (*Rose, et al. 1984; Emerman, et al. 1995; Klaustermeyer et al. 1990, Worthington, et al. 1989*).

In a large multicenter study, researchers found that a history of numerous ED visits over the previous year, a history of urgent clinic visits over the previous year, use of a home nebulizer, multiple asthma triggers, and duration of symptoms between 1 and 7 days prior to presentation were all associated with asthma recurrence during a 14-day follow-up period after controlling for age, gender, race, and primary care provider status (*Emerman, et al. 1999*). In other studies, lack of an identifiable primary care physician, three or more ED visits within the prior 6 months, and impairment in activities of daily living within the prior 4 weeks due to poor physical health were all found to be associated with a higher incidence of relapse (*McCarren, et al. 1998; Emerman, et al. 1995; Dales, et al. 1995; Ducharme, et al. 1993*).

In response to the public health problem of asthma, the National Asthma Education and Prevention Program (NAEPP) promulgates guidelines for management of asthma. The guidelines identify a number of factors such as inappropriate medical regimens, lack of access to primary medical care, home environmental factors, and social habits which may be associated with poor

asthma control and were associated with asthma. Based on this guideline, we designed a questionnaire for primary ED visit and future follow-ups. Questions about medication administration, access to primary medical care, and asthma severity classification were designed in these questionnaires according to the NAEPP guideline (*National Institutes of Health. 1997*).

The impact of asthma is not uniform across the United States, but rather disproportionately affects different communities especially those minorities in inner city settings (*Weiss, et al. 1990; Marder, et al. 1992; Lang, et al. 1994; Carr, et al. 1992*), therefore different studies have found various absolute risks (*Emerman et al 1995; Emerman et al 1998; Emerman et al 1999; McCareen et al. 1998*). Identifying risk factors for asthma relapse across a specific community could guide an effective community response to the burden of asthma (*Weiss, et al. 1999*).

Thesis objective

This project uses an inception cohort design of a random sample of adult asthma patients who present to two ED's in Grand Rapids, Butterworth and Blodgett hospitals. The goal is to identify contributing factors including demographic and clinical features for the risk of first relapse over a 26 week follow-up period after an asthma ED visit.

Chapter two: Materials and Methods

Study Overview and Study Population

The Asthma Cohort Study is one part of a three-year study in Grand Rapids funded by Center for Disease Control (CDC). The primary objectives of the cohort studies, including both adult and child study, are to develop a passive asthma surveillance system and to identify contributing factors to the relapse following an Emergency Department (ED) asthma visit. The data for this project came from adult subjects enrolled at two hospitals in Grand Rapids, Butterworth and Blodgett. Adult subjects visiting these two EDs for asthma were recruited according to the inclusion and exclusion criteria described below. Following enrollment, adult subjects completed two follow-up surveys by telephone at 2 weeks and 26 weeks following the initial ED visit. These surveys were administered by trained asthma Research Nurses at Butterworth and by Respiratory Therapists at Blodgett.

Butterworth is located in an inner city area, and Blodgett is located in a more suburban area. Both are part of the Spectrum Health System in Grand Rapids. They serve the population of the greater Grand Rapids area, which includes the counties of Kent and Ottawa. The total population of this area is about 775,000 citizens, of whom approximately 9% (67,000) are minorities. The majority of these minorities (77%) are African Americans living primarily in inner city Grand Rapids. The ED at Butterworth hospital is located in the downtown area and

serves the inner-city population of Grand Rapids and surrounding areas. In 1999, it had over 91,000 total emergency visits, with 1,755 adult and 1,032 pediatric (<18 years old) visits for asthma. The ED in Blodgett hospital is located a few miles away on the eastern side of the city. It had approximately 33,000 ED visits in 1999, including 130 adult and 310 pediatric asthma cases.

Subject Selection

Adult asthma patients seeking treatment for an acute asthma exacerbation at these two EDs were screened for eligibility. The diagnosis of asthma in the EDs in this study is based on the criteria set forth by the American Thoracic Society (*American Thoracic Society, 1986*). The standard management of acute asthma exacerbations in the EDs is consistent with the NHLBI Expert Panel 2 Guidelines (*National Heart Lung and Blood Institute, 1995*). Briefly, initial clinical assessment includes a brief history, physical examination, measure of oxygen saturation, and peak expiratory flow (PEF) (*National Heart Lung and Blood Institute, 1997*).

INCLUSION CRITERIA

To be included in this study, patients had to be 18 – 74 years old, and present to the ED with evidence of exacerbation of asthma which was defined as : any combination of wheezing, SOB (shortness of breath), chest tightness, or cough.

In addition, each patient had to have at least one of the following to be included in the study:

- a final ED discharge diagnosis of asthma, RAD (Reactive Airway Disease), or asthmatic bronchitis,

- a final ED diagnosis of chronic obstructive pulmonary disease (COPD) in patients $\leq$ 40 years of age,

- a previous physician diagnosis and/or treatment of asthma, RAD, or asthmatic bronchitis in last two years,

- a previous physician diagnosis of COPD (ever) in patients $\leq$ 40 years of age, or

- a history of using bronchodilator medication in the past year.

EXCLUSION CRITERIA

A patient was excluded from this study if any of the following conditions were true:

- had a final discharge diagnosis of chronic bronchitis or emphysema, or of COPD in persons over 40 years of age,

- had life threatening respiratory distress on presentation to the ED,

- had other significant illnesses (any major chronic disease or disability such as HIV/AIDS, immunodeficiency due to medication associated with cancer treatment or transplant, cystic fibrosis, bronchopulmonary dysplasia, or other chronic cardiopulmonary disease),

- had cognitive impairment sufficient to significantly impair ability to follow medical advice, such as drug abuse, alcoholism, major mental illness, anxiety disorder, senility, dementia, other psychosocial impairment,

- had no permanent address or access to a working telephone,

- could not communicate in English or Spanish,

- was not available for follow-up,

Data Collection

After confirming eligibility, patients were enrolled in the study after completing the consent form. Enrolled adults were interviewed by trained staff, who completed a visit form which included 32 questions *(appendix A)*. Trained asthma research nurses were used at Butterworth hospital, while Respiratory Therapists were used at Blodgett hospital. The initial visit form contained questions about demographic characteristics, including gender, age, ethnicity, race, educational attainment, and availability of health insurance. Questions were also posed about past asthma history (including previous asthma diagnosis), usual asthma care sources (including access and use of a primary care and regular asthma care providers), prior urgent care visits (including ED and hospitalization), current medications, and access to use of asthma equipment. The patient's asthma knowledge was also assessed (*see appendix A for copy of questionnaire*).

Follow-up Data

Definition of Outcome Variables

All asthma patients enrolled in this study were contacted 2 and 26-weeks after their ED visit by telephone by two Research Nurses. A structured questionnaire were used (see *Appendix B and C)*. The primary outcome of the study is the self-reported urgent medical treatment (relapse) for asthma during the 26-week follow-up period. To determine the occurrence of relapse, each patient was asked whether they had experienced worsening asthma that led them to go for urgent medical treatment since they left the hospital emergency department. Thus, our definition of relapse includes any hospitalization, unscheduled ED visit or other urgent visit to a doctor's office for worsening asthma symptoms.

We then determined when this first relapse occurred and how many relapses the patients had over the 6 month period of the study. For our survival analysis, only the first relapse in the 26-week period was used.

Definition of Exposure Variables of Interest

All demographic variables such as age, gender, race and education attainment came from interviews with the subject. Long term or chronic asthma severity was assessed over the 4-week period prior to ED visit based on four questions (*appendix A: questions 7 to 10*) according to the NHLBI guidelines *(National Institute of Health, 1997)*. Asthma severity was defined as severe, moderate,

mild persistent, and mild intermittent as assessed by determining the frequencies over the last month of both day and night symptoms, of restricted activities, and of any exacerbations severe enough to limit speech to only one or two words. The classifications of severity level was based on the highest response to each of these four questions as shown in table 2.

To examine the relative impact of recent and earlier hospitalizations on asthma relapse during the follow-up period, we used the number of recent hospitalizations (during 12 months prior to baseline interview) and whether or not the patient had ever been hospitalized in the past (question 25 of *Appendix A*). The patient's current asthma treatments were considered as appropriate if their medications meet the NHLBI guidelines relevant to their current asthma severity *(National Institute of Health, 1997)*. Alternatively, patients were considered as inappropriate treatment if their current asthma medications were less than those recommended by the guideline *(National Institute of Health, 1997) (Appendix A, question 17)*. For detailed information see table 2 and table 3.

Table 2. Classification of asthma severity: based on the evaluation of four questions over the last four weeks

	Q7. Days with symptoms	Q8. Nights with symptoms	Q9. Times with restricted activities	Q 10. Limiting speech
Severe persistent	Continual	>10/week	All the time	Yes
Moderate persistent	Every day	5-9/week	>5/week	Yes
Mild persistent	3-6/week	3-4/week	3-4/week	No
Mild intermittent	< 2 /week	< 2 /week	< 2 /week	No

Table 3. Classification of inappropriate-treatment and appropriate-treatment according to chronic asthma severity

	Inappropriate treatment	Appropriate treatment
Severe persistent	Without daily combinations in the proper treatment	Daily Long term: ICS&LABA; CSBA; ICS & Theophylline PLUS Quick Relief: SABA
Moderate persistent	Without daily treatment in the proper treatment	Daily Long term: ICS; LABA; Theophylline PLUS Quick Relief: SABA
Mild persistent	Without long term control medications at all	One Daily Long term: ICS; Theophylline PLUS Quick Relief: SABA
Mild intermittent	No medications used	No daily medication, but use SABA to control symptoms

Note: ICS: inhaled corticosteroid; LABA: long-acting beta$_2$-agonist; CSBA: combined SABA and ICS; SABA: short-acting beta$_2$-agonist.

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Statistics Analysis

Data were analyzed using SAS 8.2 software (SAS Institute, Cary, NC, USA). Since the study was still ongoing, we restricted the data to the 172 subjects who were enrolled up until September 16, 2002. At this time, 138 (80%) of patients had completed the 26-week follow-up interview. All of our analyses are based on these 138 patients.

In order to show that the sample in this study is a representative of the whole ED population, we generated descriptive statistics of the ED patient populated in Butterworth and Blodgett hospitals, Grand Rapids. We first compared the gender, age and race distribution between the enrolled cohort and the group who were screened but not enrolled in this study, and then we also compare the enrolled cohort and all adult asthma ED visits in 2001 as determined by analysis of ED billing data.

To identify the contributing factors for asthma relapse over the 26-weeks period, we used survival analysis (Cox proportional hazard model). In order to investigate what demographic or clinical factors were associated with asthma relapse over the 26-weeks period. Univariate survival analysis was first conducted followed by subsequent multivariate survival analysis. Initial candidate variables were those associated with relapse ($p<0.20$) in the univariate analysis. Backward selection procedures using PROC PHREG tie=discrete, were used for

variable selection. In this process, exclusion p-values were set at >0.15. We chose to develop the model using only information collected at the initial ED visit. Since recent hospitalizations are associated with asthma severity, we repeated the analysis with the level of severity included and not included in the model. Age group (18-35, over 35 years old), gender, race group (white vs. non-white), and education attainment (up to high school graduation, or greater than high school) were considered as a priori confounders, because these common demographic variables have been identified as risk factor in previous studies (*Adams, et al. 2000; Emerman et al. 1999*).

Results

Description of the included hospitals and subjects

In the period up to September 2002, 172 adult asthma patients were enrolled in the study. Of these, 120 (69.8%) subject enrolled are from Butterworth ED's and 52 (30.2%) from Blodgett ED's. A total of 274 subjects were screened at these 2 ED's and 102 were not eligible or declined participants and thus not enrolled. Subjects who were enrolled for this project did not differ in gender from those who were screened but not enrolled, however they did differ significantly in both race and age (Table 4). Subjects who were screened but not enrolled include those who declined consent, had other significant illness or were not available for follow up. Patients included in the cohort study were younger than those who were excluded: the mean ages are 36.1 ± 11.2 and 40.6 ± 15.0 (mean$\pm$SD), respectively ($p<0.01$). African Americans were more likely to be included in the study than non-hispanic whites (Table 4).

We were also able to compare the patients population enrolled in the study to an ED database of all adult asthma ED visits in 2001. We found that the adult asthma ED visits enrolled in this cohort study were not different in term of gender or age from all adult asthma ED visits in 2001 of the same age group (18-74), e.g. percent of female visits is 74.2% in this study versus 70.8% in 2001, age group distributions were similar between this study and 2001 data (Figures 1 and 2).

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Table 4. Comparison of Included and Excluded Patients in Butterworth and Blodgett

	Excluded		Included		p-value
Sex	N	%	N	%	0.68
Male	29	39.2%	45	60.8%	
Female	73	36.5%	127	63.5%	
Race					<0.01
White-Hispanic	3	18.8%	13	81.3%	
White-Non-Hispanic	47	34.6%	89	65.4%	
African American	16	22.2%	56	77.8%	
Other	1	6.7%	14	93.3%	
	67*		172		

* 35 subjects did not provide race indication.

Figure 1. Comparison of gender between adult asthma ED visits in 2001 (data generated from billing data) with those subjects enrolled in this study.
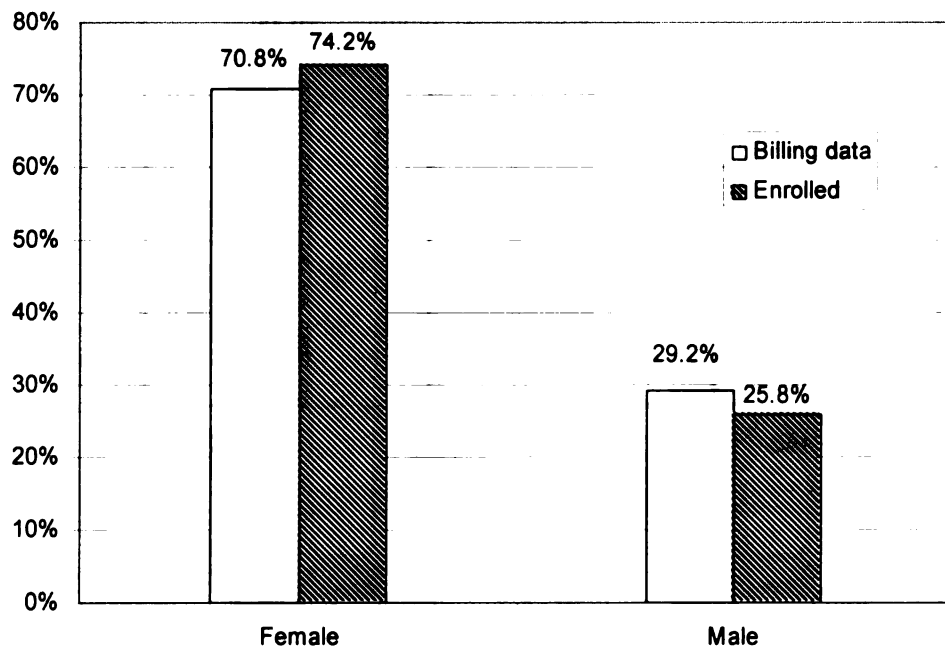
Figure 2. Comparison of age in adult asthma ED visits in 2001 (data from Physician Billing Company) with those in this study.
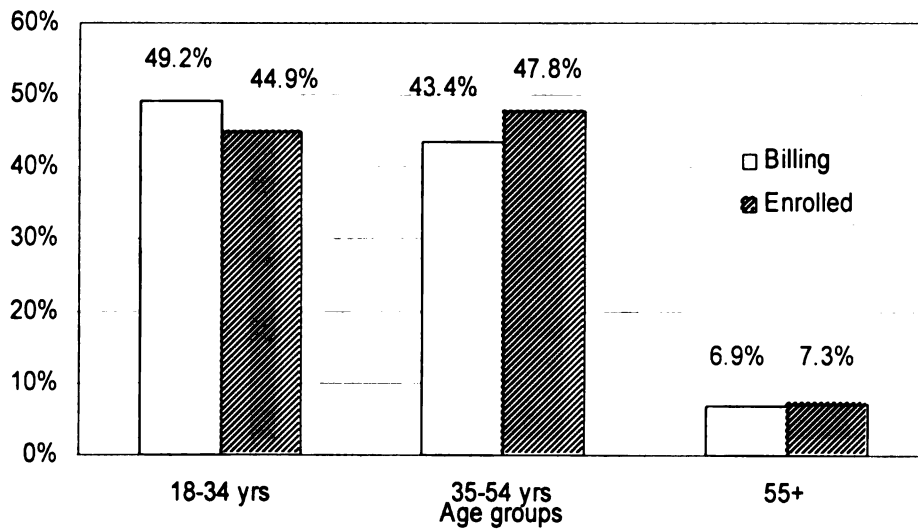
By September 16, 2002, a total of 172 patients had been enrolled in this project and 138 of them (80%) had completed the 26-week follow-up.

Of the 172 patients enrolled, 120 (70%) were from Butterworth hospital, the main study base, and 52 (30%) were from Blodgett hospital. One hundred and fifty (87%) had been interviewed 2 weeks after the ED visit, while 138 (82%) had been interviewed after 26 weeks and thus completed all follow up. Of the 34 subjects for whom no 26-week follow-up was obtained, 4 (12%) declined to be interviewed, while 30 (88%) were not reachable (Figure 3. For details, see appendix D).

The subjects who completed follow up did not differ significantly in age, gender, and race from those that did not complete follow up (Table 5). The mean ages for those that completed the 26-week follow up and those that did not were 36.8±11.5 and 33.4±9.8 (mean ±SD), respectively.

Figure 3. Flow chart of follow-up of enrolled subjects
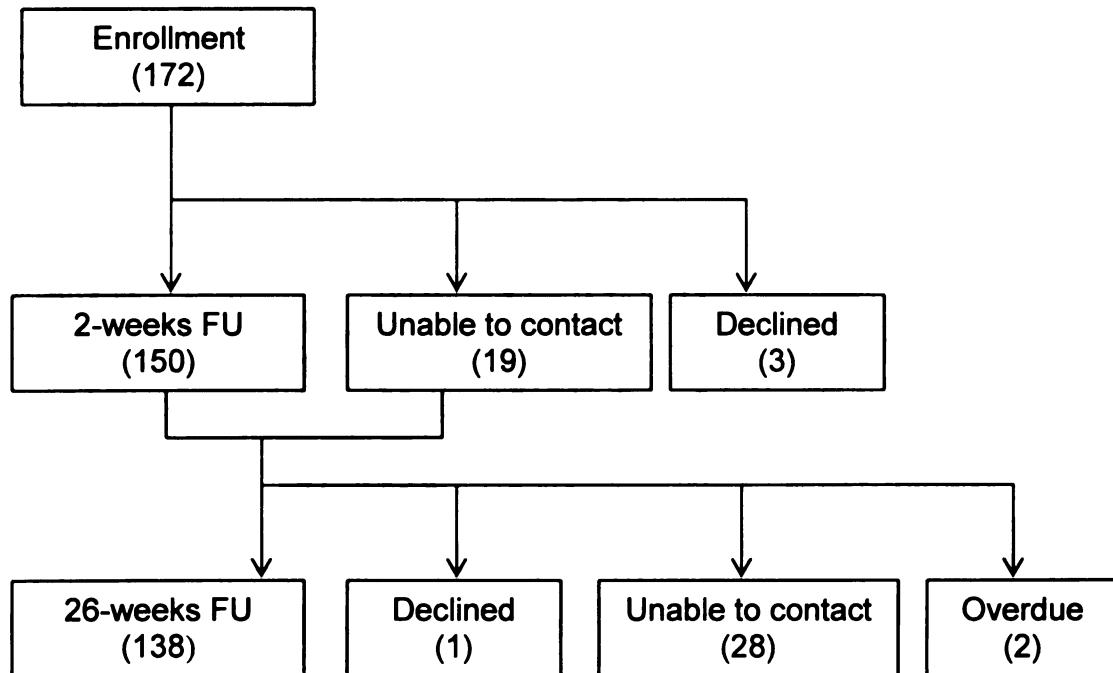
Table 5. Comparison of patients who completed the 26-week follow-up with those who did not

	Interviewed	%	Not Interviewed	%	Total	P-value
Sex						0.08
Female	106	83.5	21	16.5	127	
Male	32	71.1	13	28.9	45	
Age						0.1
18-35 yr.	62	74.7	21	25.3	83	
35-54 yr.	66	84.6	12	15.4	78	
55+ yr.	10	90.9	1	9.1	11	
Race						0.45
White Hispanic	10	76.9	3	23.1	13	
White Non-Hispanic	73	82.0	16	18.0	89	
African American	41	73.2	15	26.8	56	
Other	13	92.9	1	7.1	14	

Description of the baseline characteristics

Table 6 lists the baseline characteristics of the 172 subjects. The typical adult asthma ED visitor in this project was female (74%) and white non-Hispanic (59.3%), and presented with a complaint of short of breath (SOB), difficult breathing or asthma. The age range was 18-74 years, and, forty nine percent (83) were 18-34 years, forty five percent (78) were 35-54 years, and six percent (11) were older than 55 years. Eighty one percent of them had at least high school education. The majority of patients were classified as having mild intermittent asthma (61%); only a few of the subjects had severe persistent asthma (3%), so this group was combined with subjects who had moderate persistent asthma. More than half of the subjects (59%) had private health insurance coverage, while 14% of them had no health insurance. About 75% of patients reported they had a primary care provider for their regular asthma care. Thirty three percent were cigarette smokers, twenty six percent were former cigarette smokers and thirty eight percent never smoked. Fifty eight percent of the subjects reported they had been hospitalized for asthma overnight at least once, but among them 44% (61) reported no hospitalizations in the last 12 months. Eighty three percent of the subjects reported ever having had an ED visit for urgent treatment of asthma symptoms, of whom 68% had at least one ED asthma visit in the last 12 months.

Table 6: Description of baseline characteristics of 172 adult asthma ED visits

	N	%
Age		
18-34 yr.	83	48.3
35-54 yr.	78	45.3
55+ yr.	11	6.4
Sex		
Females	127	73.8
Males	45	26.2
Race		
White non-Hispanic	89	51.7
White Hispanic	13	7.6
African American	56	32.6
Other	14	8.1
Education Attainment		
Less than high school	33	19.2
High school or GED	61	35.5
1-3 years of college	56	32.6
4-year college or more	22	12.8
Asthma Severity		
Moderate persistent & severe	37	21.5
Mild persistent	29	16.9
Mild intermittent	106	61.6
Insurance Status		
None	24	14.0
Private	101	58.7
Public	47	27.3

Characteristics of patients who had relapse and who did not

Thirteen of the patients (10%, 13/138) relapsed during the first 2-week follow—up period, and 27 more (30%, 40/138) relapsed during the 2-week to the 26-week follow-up period (Figure 4). In the future survival analysis below, not counted are two patients who reported relapse but did not give the date when it occurred. Descriptive characteristics for patients in this study who had relapse compared to those that did not show in Table 7.

Figure 4. Time interval in weeks between ED visit and the first relapse for the 138 subjects who completed 26-weeks follow-up

Time Interval from ED Date to First Relapse
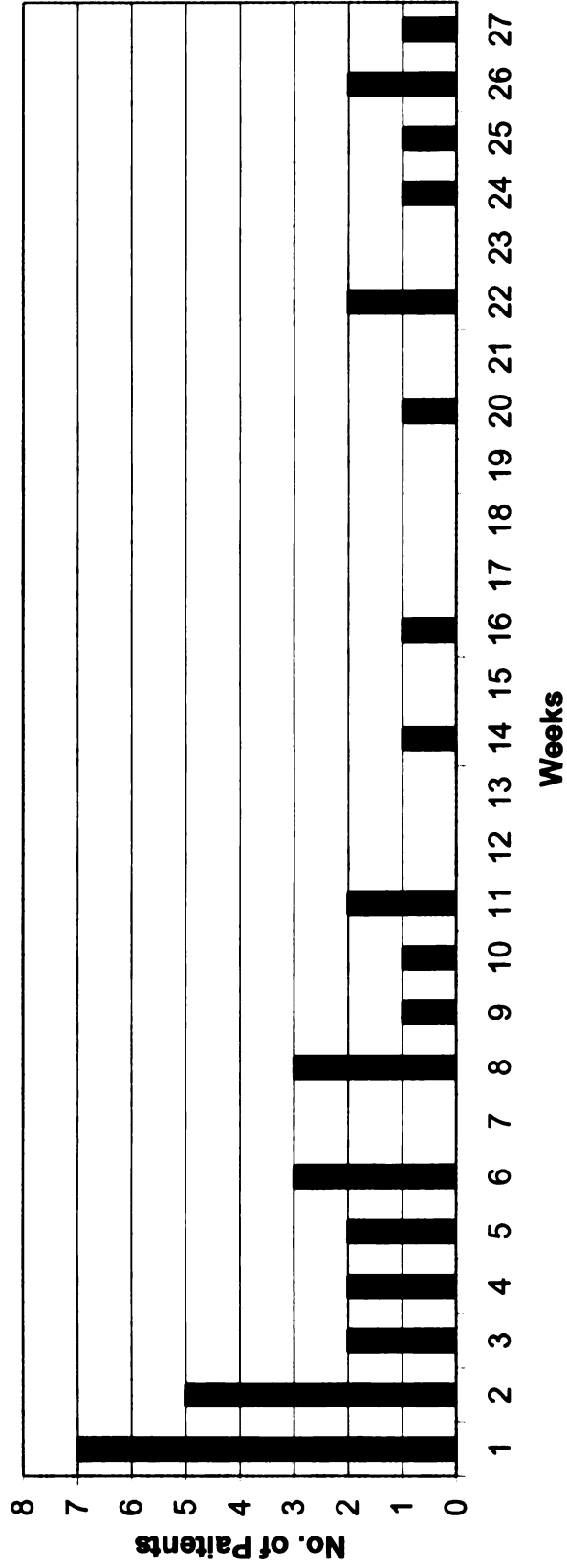
Note: 2 subjects with relapse but not report the date of first relapse.

Table 7. Association between demographic, clinical treatment and management factors and adult asthma relapse during a 6- month period. Univariate Cox proportional models show hazard ratio and 95% confidence interval

	Total	Relapse		HR	95% CI	Walds P value	Global model		
	N=138	n=40	%				LRCS	df	p value
Age (3 levels)							1.05	2	0.59
18-34 yr.	62	18	29	1.00	—				
35-54 yr.	66	20	30	1.31	0.68-2.50	0.42			
55+ yr.	10	2	20	0.75	0.17-3.26	0.71			
Age (2 levels)							0.39	1	0.53
18-35 yr.	62	18	29	1.00	—				
35+ yr.	76	22	29	1.23	0.65-2.32	0.53			
Sex							1.01	1	0.32
Females	106	33	31	1.00	—				
Males	32	7	22	0.67	0.29-1.51	0.34			
Race (4 levels)							2.13	3	0.55
White non-Hispanic	73	19	26	1.00	—				
White Hispanic	10	3	30	1.21	0.36-4.12	0.76			
African American	42	12	29	1.17	0.56-2.42	0.68			
Other	13	6	46	2.08	0.83-5.25	0.12			
Race (2 levels)							0.79	1	0.38
White	83	22	27	1.00	—				
Non-white	55	18	33	1.33	0.71-2.50	0.37			

Table 7. Association between demographic, clinical treatment and management factors and adult asthma relapse during a 6- month period. Univariate Cox proportional models show hazard ratio and 95% confidence interval

	Total	Relapse		HR	95% CI	Walds P value	Global model LRCS	df	p value
	N=138	n=40	%						
Education Attainment (4 levels)							4.95	3	0.18
Less than high school	24	4	17	1.00	—	—			
High school or GED	48	11	23	1.48	0.47-4.66	0.50			
1-3 years of college	46	19	41	2.74	0.93-8.10	0.07			
4-year college or more	20	6	30	2.05	0.58-7.26	0.27			
Education Attainment (2 levels)						4.07		1	0.04
High school or less	72	15	21	1.00	—	—			
More than high school	66	25	38	1.92	1.01-3.67	0.05			
Asthma Severity							5.15	2	0.08
Severe & Moderate persist.	28	11	39	1.00	—	—			
Mild persistent	26	12	46	1.12	0.47-2.63	0.80			
Mild intermittent	84	17	20	0.51	0.24-1.08	0.08			
Insurance status							3.78	2	0.15
None	15	4	27	1.00	—	—			
Private	89	21	24	1.29	0.37-4.31	0.68			
Public	34	15	44	2.41	0.69-8.38	0.17			
Asthma diagnosed							0.30	1	0.59
No	9	2	22	1.00	—	—			
Yes	129	38	29	1.45	0.35-6.02	0.61			

Table 7. Association between demographic, clinical treatment and management factors and adult asthma relapse during a 6- month period. Univariate Cox proportional models show hazard ratio and 95% confidence interval

	Total	Relapse	%	HR	95% CI	Walds P value	Global model		
	N=138	n=40					LRCS	df	p value
Asthma care							1.51	2	0.47
No asthma doctor	20	5	25	1.00	—				
PCP being asthma doctor	103	29	28	1.46	0.51-4.14	0.48			
Asthma specialist	15	6	40	2.19	0.62-7.76	0.41			
Ever taken oral steroids							2.46	1	0.12
No	34	6	18	1.00	—				
Yes	104	34	33	1.91	0.80-4.56	0.15			
Able to fill prescription							0.59	1	0.44
Yes	114	30	26	1.00	—				
No	20	8	40	1.40	0.61-3.18	0.43			
Missing	4	2	50						
Access to spacer							6.40	1	0.01
Yes	65	26	40	1.00	—				
No	73	14	19	0.44	0.23-0.84	0.01			
If yes, frequency of use							0.07	1	0.79
Used regularly	29	12	41	1.00					
Not used regularly	35	14	40	0.90	0.41-1.97	0.79			
Missing	1	0	0						

Table 7. Association between demographic, clinical treatment and management factors and adult asthma relapse during a 6- month period. Univariate Cox proportional models show hazard ratio and 95% confidence interval

	Total	Relapse	%	HR	95% CI	Walds P value	Global model		
	N=138	n=40					LRCS	df	p value
Access to PFM									
Yes	72	28	39	1.00	—		7.93	1	0.01
No	66	12	18	0.39	0.19-0.78	0.01			
If yes, frequency of use									
Used regularly	17	12	71	1.00	—		7.79	1	0.01
Not used regularly	55	16	29	0.31	0.15-0.68	<0.01			
Have AMP									
Yes	48	18	38	1.00	—		1.72	1	0.19
No	90	22	24	0.65	0.35-1.23	0.19			
Ever received education									
Yes	71	26	37	1.00	—		5.03	1	0.02
No	66	13	20	0.48	0.25-0.93	0.03			
Ever been hospitalized									
No	55	9	16	1.00	—		6.55	1	0.01
Yes	83	31	37	2.48	1.18-5.22	0.02			
Number of hospitalizations last 12 months									
0	109	24	22	1.00	—		14.17	2	<0.01
1	12	5	42	2.26	0.87-5.96	0.10			
2+	17	11	65	4.46	2.16-9.18	<0.01			

Table 7. Association between demographic, clinical treatment and management factors and adult asthma relapse during a 6- month period. Univariate Cox proportional models show hazard ratio and 95% confidence interval

	Total	Relapse	%	HR	95% CI	Walds P value	Global model		
							LRCS	df	p value
	N=138	n=40							
Ever gone to ED for asthma							6.93	1	0.01
No	18	1	6	1.00	—	—			
Yes	114	38	33	6.78	0.93-49.38	0.06			
Missing	6	1	17						
Number of ED visits last 12 months							8.57	2	0.01
0	51	9	18	1.00	—	—			
1	23	6	26	1.64	0.58-4.60	0.35			
2+	55	23	42	2.94	1.36-6.37	0.01			
Missing	9	2	22						
Smoking status							1.88	2	0.39
Never	52	18	35	1.00	—	—			
Former	36	9	25	0.73	0.33-1.62	0.44			
Current	45	11	24	0.59	0.27-1.29	0.19			
Missing	5	2	40						
Under treatment*							3.21	1	0.07
No	93	23	25	1.00	—	—			
Yes	45	17	38	1.79	0.96-3.33	0.07			

Note: 95% CI: 95% hazard ratio confidence limits; AMP: asthma management plan; df: degree of freedom; ED: emergency department; HR: Hazard Ratio; LR: likelihood ratio; PCP: primary care provider; PFM: peak flow meter; LRCS: likelihood ratio chi square. *for definition see table 2 and table 3.

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Development of Cox proportional hazard model

Univariate analysis

The univariate analysis of associations between baseline characteristics and the primary outcome of relapse during the 26-week follow-up period is listed in Table 7. The strongest associations according to the p value were for access to a spacer, access to a peak flow meter (PFM); having ever received asthma education from a health professional; having ever been hospitalized, frequency of hospitalization in the last 12 months, having ever gone to an emergency room for urgent treatment of asthma symptoms, frequency of emergency room visits for urgent treatment of asthma symptoms, and asthma treatment appropriateness. Because our sample size is small, we defined the significance level as 20% to identify variables to be included in the multivariate Cox proportional hazards model.

Modeling variables

Asthma severity can be regarded as either a risk factor, a confounder, or a mediator on the pathway from ED visit to asthma relapse. Therefore, two models were developed: one where severity was included and one where it was not.

Association of asthma severity with all variables

Several factors, such as use of a spacer, PFM, AMP, and asthma education were strongly associated with the patients' chronic or long-term asthma severity. One group of variables were regarded as marker variables of asthma severity: use of a spacer or a PFM, having an asthma management plan, having received asthma education. Among these factors, regular use of a PFM and having an asthma management plan were strongly associated with asthma severity ($P<0.03$) (Table 8). Having ever been hospitalized overnight for asthma symptoms, frequency of hospitalization in the last 12 months, having ever gone to an ED for asthma symptoms, frequency of ED visits for asthma, and treatment appropriateness are also associated with asthma severity (Table 8), but were not regarded as marker variables.

Table 8. Association between asthma severity with other variables that have strong association with asthma relapse.

Variables	P values
Age	0.03
Gender	0.25
Insurance status	0.59
Education attainment	0.43
Use spacer regularly	0.06
Use PFM regularly	<0.01
Have asthma management plan	0.03
Received asthma education	0.20
Ever taken steroid	<0.01
Ever been hospitalized overnight for asthma	<0.01
Frequency of hospitalization in last 12 months	<0.01
Ever gone to Emergency room for asthma	0.64
Frequency of going to ED for asthma	0.04
inappropriate-treatment	<0.01

Multivariate analysis

Model Selection using Marker variables

Following the univariate analysis (Table 7), all variables with p-value less than 0.20 were considered in the model selection regardless of whether we regarded them as marker variables, e.g. indicator of asthma severity. Age, gender, race, and education were included as potential confounders, regardless of statistical significance. The results of this multivariate analysis are presented in Table 9.

The final model included only one significant variable-the frequency of hospitalization in the last 12 months. This result was not affected by whether asthma severity was considered in the model or not (based on a significance level of 5%) (models 14 and 25).

If the significance level was increased to a 10%, two models were generated. The model that included asthma severity identified two variables: use of a spacer and the frequency of hospitalization over the last 12 months as significant (model 13). The model which did not consider asthma severity identified three variables: use of a spacer, having ever received asthma education, and the frequency of hospitalization (model 24). (For details, see Table 9).

Table 9. Summary of Model Selection I including all variables with age, race, and education coded at 2 levels

	A priori confounders				Possible mediator	Possible risk factors											Model selection			
	Age	Sex	Race	Educate		ER2	Hosp1	INS	EverSb	AMP	PPM	Treat	ER1	AbEdu	Spacer	Hosp2	-2LogL	LRCS	df	P Value
Model 1																	371.78			
Model 2	Yes	Yes	Yes	Yes													365.22	[1-2] 6.56	4	0.16
Model 3	Yes	Yes	Yes	Yes	Yes												361.58	[2-3] 3.64	2	0.16
Severity Included																				<0.01
Model 5	Yes	Yes	Yes	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	339.15	*[5-4] 0.03	2	0.99
Model 6	Yes	Yes	Yes	Yes	Yes	1	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	339.18	[6-5] 0.03	1	0.86
Model 7	Yes	Yes	Yes	Yes	Yes	1	2	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	340.02	[7-6] 0.84	2	0.66
Model 8	Yes	Yes	Yes	Yes	Yes	1	2	3	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	340.78	[8-7] 0.76	1	0.38
Model 9	Yes	Yes	Yes	Yes	Yes	1	2	3	4	5	Yes	Yes	Yes	Yes	Yes	Yes	341.53	[9-8] 0.75	1	0.39
Model 10	Yes	Yes	Yes	Yes	Yes	1	2	3	4	5	6	Yes	Yes	Yes	Yes	Yes	342.43	[10-9] 0.90	1	0.34
Model 11	Yes	Yes	Yes	Yes	Yes	1	2	3	4	5	6	7	Yes	Yes	Yes	Yes	343.75	[11-10] 1.32	1	0.25
Model 12	Yes	Yes	Yes	Yes	Yes	1	2	3	4	5	6	7	8	Yes	Yes	Yes	345.74	[12-11] 1.99	1	0.16
Model 13	Yes	Yes	Yes	Yes	Yes	1	2	3	4	5	6	7	8	9	Yes	Yes	348.37	[13-12] 2.63	1	0.10
Model 14	Yes	Yes	Yes	Yes	Yes	1	2	3	4	5	6	7	8	9	10	Yes	351.58	[14-13] 3.21	1	0.07
Model 14	Yes	Yes	Yes	Yes	Yes	1	2	3	4	5	6	7	8	9	10	Yes	351.58	[3-14] 10.00	1	<0.01

Table 9. Summary of Model Selection I including all variables with age, race, and education coded at 2 levels

	A priori confounders				Possible mediator	Possible risk factors											Model selection				
	Age	Sex	Race	Educate	severity	ER2	Hosp1	INS	EverSo	AMP	PFM	Treat	ER1	AsEdu	Spacer	Hosp2	-2LogL	LRCS	Df	df	P value
Severity Excluded																					
Model 16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	329.05	[2-15]	36.17	14	<0.01
Model 17	Yes	Yes	Yes	Yes		1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	339.35	[16-15]	0.07	2	0.97
Model 18	Yes	Yes	Yes	Yes		1	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	339.37	[17-16]	0.02	1	0.89
Model 19	Yes	Yes	Yes	Yes		1	2	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	340.17	[18-17]	0.80	2	0.67
Model 20	Yes	Yes	Yes	Yes		1	2	3	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	340.88	[19-18]	0.71	1	0.40
Model 21	Yes	Yes	Yes	Yes		1	2	3	4	5	Yes	Yes	Yes	Yes	Yes	Yes	341.57	[20-19]	0.69	1	0.41
Model 22	Yes	Yes	Yes	Yes		1	2	3	4	5	6	Yes	Yes	Yes	Yes	Yes	342.62	[21-20]	1.05	1	0.31
Model 23	Yes	Yes	Yes	Yes		1	2	3	4	5	6	7	Yes	Yes	Yes	Yes	344.74	[22-21]	2.12	1	0.15
Model 24	Yes	Yes	Yes	Yes		1	2	3	4	5	6	7	8	Yes	Yes	Yes	346.90	[23-22]	2.16	1	0.14
Model 25	Yes	Yes	Yes	Yes		1	2	3	4	5	6	7	8	9	Yes	Yes	349.94	[24-23]	3.04	2	0.08
Model 25	Yes	Yes	Yes	Yes		1	2	3	4	5	6	7	8	9	10	Yes	353.53	[25-24]	3.59	1	0.06
Model 25	Yes	Yes	Yes	Yes		1	2	3	4	5	6	7	8	9	10	Yes	353.53	[2-25]	11.69	9	<0.01
Model 25	Yes	Yes	Yes	Yes		1	2	3	4	5	6	7	8	9	10	Yes	353.53	[25-14]	1.95	1	0.16

Note: a LRCS is based on a 130 observations on 130 observations due to missing values; Age: agegroups (35-54 or 55+ vs. 18-34); AMP: asthma management plan; AsthEdu: ever received asthma education; EverEr: ever gone to ER; ER: frequency of ER visits in the last 12 months; EverSo: ever taken steroid; Hosp1: ever been hospitalized; Hosp2: frequency of hospitalization in last 12 months; INS: insurance status (private, public and none); PFM: access to peak flow meter; Race: race status (white hispanic, black and other); severity: three severity levels including mild intermittent, mild persistent, moderate persistent; spacer: access to spacer; treat: undertreatment vs. not undertreatment.

Model Selection without marker variables

The marker variables were not regarded as real risk factors, since they are potential indicators of the underlying asthma severity. This situation arises because the more severe the asthma, the more likely a patient is to use a spacer and PFM, receive asthma education, and have an asthma management plan (Table 7). Therefore, we conducted analysis where we excluded these variables. Controlling for age, gender, race, and education, the final model included only the frequency of hospitalization in the last 12 months at significance levels of both 5% and 10%, regardless of whether severity was considered. The results of this multivariate analysis are presented in Table 10.

Table 10. Summary of Model Selection II (asthma severity indicators: spacer, PFM, AMP and AsthEdu are not included in the process of model selection; age, race, and education were coded in two levels)

	A priori confounders				Possible mediator	Possible risk factors							Model selection			
	Age	Sex	Race	Educate	Severity	ER2	Hosp1	INS	EverSo	Treat	ER1	Hosp2	-2LogL	LRCS	Df	P value
Model 1													371.78			
Model 2	Yes	Yes	Yes	Yes									365.22	[1-2] 6.56	4	0.16
Model 3	Yes	Yes	Yes	Yes	Yes								361.58	[2-3] 3.64	2	0.16
Severity included																
Model 4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	333.72	[3-4] 27.86	10	<0.01
Model 5	Yes	Yes	Yes	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	346.37	*[5-4] 0.41	2	0.81
Model 6	Yes	Yes	Yes	Yes	Yes	1	Yes	3	2	Yes	Yes	Yes	346.73	[6-5] 0.36	1	0.55
Model 7	Yes	Yes	Yes	Yes	Yes	1	Yes	3	2	Yes	Yes	Yes	346.95	[7-6] 0.22	2	0.90
Model 8	Yes	Yes	Yes	Yes	Yes	1	4	3	2	Yes	Yes	Yes	347.51	[8-7] 0.56	1	0.45
Model 9	Yes	Yes	Yes	Yes	Yes	1	4	3	2	5	Yes	Yes	348.69	[9-8] 1.18	1	0.28
Model 10	Yes	Yes	Yes	Yes	Yes	1	4	3	2	5	6	Yes	351.58	[10-9] 2.89	1	0.09
Severity excluded																
Model 11	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	334.17	[2-11] 31.05	10	<0.01
Model 12	Yes	Yes	Yes	Yes		1	Yes	Yes	Yes	Yes	Yes	Yes	346.73	*[12-11] 0.72	2	0.70
Model 13	Yes	Yes	Yes	Yes		1	Yes	3	2	Yes	Yes	Yes	346.73	[13-12] 0.00	1	1.00
Model 14	Yes	Yes	Yes	Yes		1	Yes	3	2	Yes	Yes	Yes	347.32	[14-13] 0.59	2	0.74
Model 15	Yes	Yes	Yes	Yes		1	4	3	2	Yes	Yes	Yes	347.95	[15-14] 0.63	1	0.43
Model 16	Yes	Yes	Yes	Yes		1	4	3	2	5	Yes	Yes	351.15	[16-15] 3.20	1	0.07
Model 17	Yes	Yes	Yes	Yes		1	4	3	2	6	5	Yes	353.53	[17-16] 2.38	1	0.12

Note: * LRCS is based on a 130 observations due to missing values; Age: agegroups (35-54 or 55+ vs. 18-34); AMP: asthma management plan; AsthEdu: ever received asthma education; EverEr: ever gone to ER; ER: frequency of ER visits in the last 12 months; EverSo: ever taken steroid; Hosp1: ever been hospitalized; Hosp2: frequency of hospitalization in last 12 months; INS: insurance status (private, public, and none); PFM: access to peak flow meter; Race: race status (white hispanic, black and other); severity: three severity levels including mild intermittent, mild persistent, moderate persistent; spacer: access to spacer; treat: undertreatment vs. not undertreatment.

Kaplan-Meier survival curves for the three groups according to the

frequency of previous hospitalization in previous year

We plotted Kaplan-Meier curves based on survival function S(t) versus follow-up

time in weeks for the three groups: 0 time of hospitalization, 1 time of

hospitalization and more than 2 times of the hospitalizations (Figure 5). This plot

shows asthma patients having 0 time of hospitalization in previous year have the

best survival probability than those having 1 or 2 times of hospitalization.

Final Model

Our final model concluded that only the frequency of hospitalization in the last 12

months was a significant risk factor (table 12). With asthma severity in the model,

the hazard ratio is 3.1 (95% CI 1.1-8.6) if the patient had 1 hospitalization in the

last 12 months. When the patient had 2 or more hospitalization, the hazard ratio

increased to 3.3 (95% CI 1.4-7.8). When asthma severity was excluded from the

model, the hazard ratio declined slightly to 2.5 (95% CI 1.0-6.7) if the patient had

1 hospitalization in the last 12 months, but increased to 4.1 (95% CI 1.8-9.2) if

the patient had 2 or more hospitalizations (Table 11);

Figure 5. Survival distribution of previous hospitalization for three groups (0 time of hospitalization, 1 time of hospitalization and more than 2 times of hospitalization in previous 12 months.

Survival curve of frequency of hospitalization vs weeks of follow—up
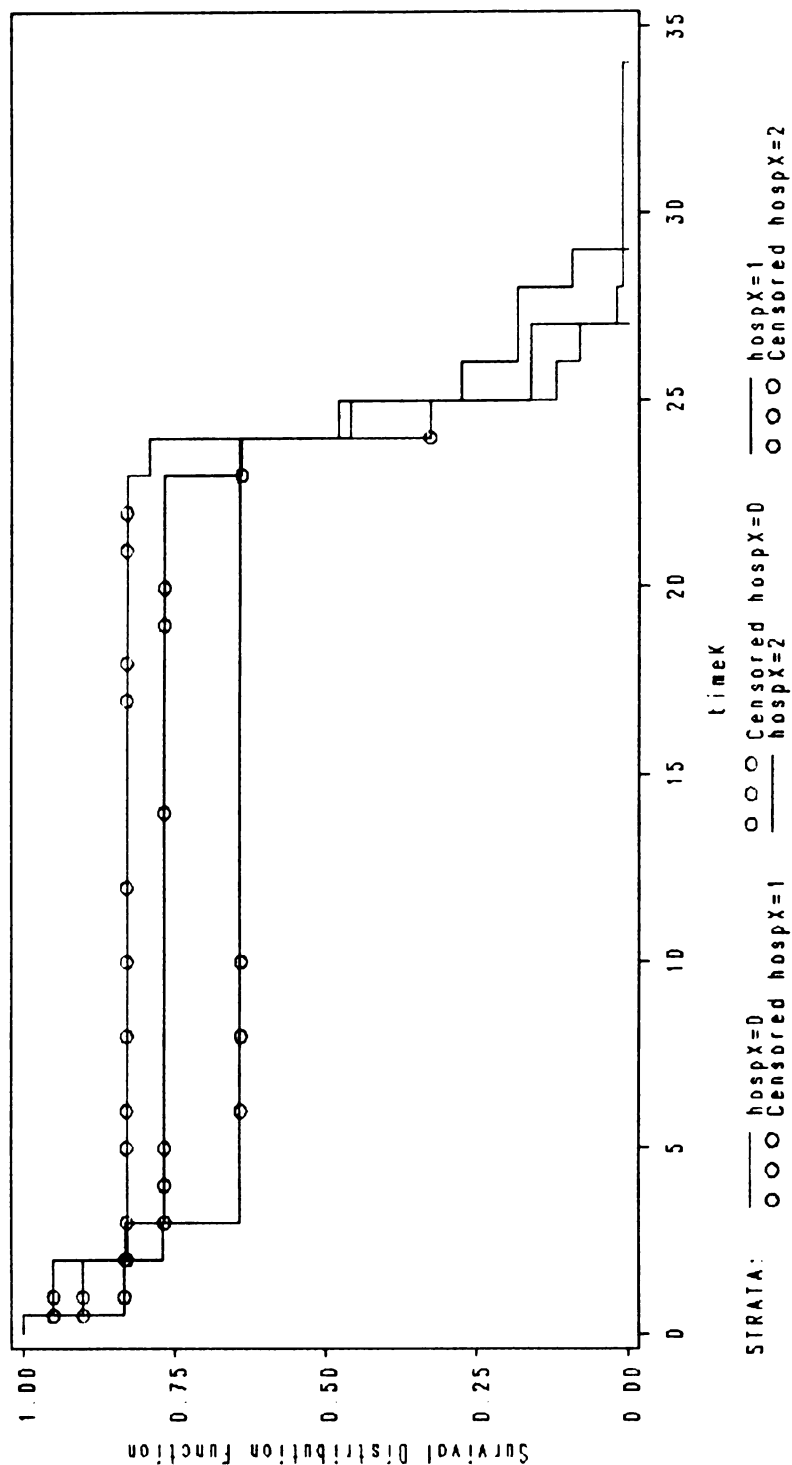
Note: hospX : frequency of hospitalization in previous 12 months; timeK: first relapse in weeks.

Table 11. Final multivariate model for adult asthma relapse over a 6 month period

Models Factors	Factor levels	HR	95% HR CI	p value
Model 1 (Includes severity)				
Age	18-35 yr.	1.36	0.67-2.74	0.4
	35+ yr.	1	_	_
Sex	Females	1.37	0.57-3.26	0.48
	Males	1	_	_
Race	Non-white	1.21	0.61-2.40	0.58
	White	1	_	_
Education attainment	More than high school	1.81	0.91-3.63	0.09
	High school or less	1	_	_
Severity[1]				
	Severe & Moderate persistent	1.76	0.75-4.13	0.2
	Mild persistent	1.64	0.68-3.95	0.27
	Mild intermittent	1	_	_
Frequency of hospitalization[2]				
	More than 2 hospitalizations	3.28	1.38-7.76	0.01
	1 hospitalization	3.09	1.10-8.64	0.03
	0 hospitalization	1	_	_
Model 2 (excluded severity)				
Age	18-35 yr.	1.28	0.63-2.60	0.49
	35+ yr.	1	_	_
Sex	Females	1.32	0.56-3.12	0.52
	Males	1	_	_
Race	Non-white	1.2	0.61-2.37	0.59
	White	1	_	_
Education attainment	Beyond high school	1.86	0.93-3.71	0.08
	High school or less	1	_	_
Frequency of hospitalization[3]				
	More than 2 hospitalizations	4.08	1.80-9.23	<0.01
	1 hospitalization	2.53	0.95-6.74	0.06
	0 hospitalization	1	_	_

Note: 1=LRCS (2 degree of freedom), p=0.28; 2= LRCS (2 degree of freedom), p=0.001; 3=LRCS (2 degree of freedom), p<0.01;

Chapter four: Discussion

1. Description of patient cohort

This patient cohort comprised adults aged 18-74 years with acute asthma

presenting to the two emergency departments of Butterworth and Blodgett

Hospitals between November 2001 and September 2002. Two thirds were

female, about half of the cohort were younger than 35 years old, and more

than 60% were white. Most of the subjects were covered by private health

insurance and had at least high school education. The majority of individuals

had either mild intermittent or mild persistent asthma; only 21.5% suffered

moderate to severe asthma. The primary outcome was defined as at least

one urgent care visit for asthma after the initial ED visit, where urgent care

visit was defined as ED, or other unscheduled office visit. The short-term (2

weeks) rate of relapse was fairly low (10%), while the long-term (26 weeks)

rate of relapse was 30%. Gender, age distribution, education level and

insurance status were similar to other adult cohorts in the published literature,

except higher proportion of whites in our study (*MaCarren, et al. 1998;*

Emerman, et al. 1999; Adams, et al. 2000; Ford, et al. 2001).

The data were collected as part of the baseline assessment for the Grand

Rapids Asthma Cohort Study. Comparison of included and excluded subjects

showed that there were no significant differences between them in terms of

demographic characteristics indicating that this patient cohort was representative of all ED asthma visits at the study hospitals.

2. Occurrence of relapse and risk factors for relapse

Asthma remains a common clinical condition affecting approximately 14 million people (*MMWR, 1995*). In 2001, an estimated 31.3 million persons reported having had asthma diagnosed, and 20.3 million persons currently had asthma. Each year, between 5% and 10% of these asthmatic patients will have an acute exacerbation requiring a visit to the emergency department (*MMWR, 2003*).

Despite significant advances in our understanding of asthma, relapse remains a substantial problem. There remains a significant proportion of patients relapsing and requiring urgent medical treatment after presenting to an ED (*Emerman, 2000*). Previous studies showed that short-term (within 2 weeks) relapse rates ranged from 6% to 17%, and that long-term relapse rate (8 weeks) was around 45% (*MaCarren, et al. 1998; Emerman, et al. 1999; Adams, et al. 2000; Ford, et al. 2001*. Our study found a 10% of short-term and 30% of long-term relapse rate among the 138 patients.

Previous studies found the following factors were associated with asthma relapse: knowing the name of their primary care physician (which was taken

as a marker for access to follow-up care), inability to obtain their discharge medications, simple measures of pulmonary function (PEV1), frequent previous ED visits and previous hospitalizations, multiple triggers for asthma, use of a home nebulizer, and a duration of symptoms between 1 and 7 days (*Emerman, et al. 1998; Nowak et al. 1982; Emerman, et al. 1995; Emerman, et al. 1999*). However, other previous studies have not confirmed that these risk factors, finding no association between pulmonary function, and duration of symptoms, and asthma relapse. (*Worthington, et al. 1989; Martin, et al. 1982; Klaustermeyer, et al. 1990; Cross, et al. 1991; Chan-Yeung, et al. 1996*).

There is no consistent standard in the literature for a definition of relapse or recurrence or for the length of time used to measure an asthma relapse. However, researchers such as Emerman have defined relapse and recurrence as an unscheduled clinic or ED visit for an asthma exacerbation, *(Emerman et al. 1998)*, and Camargo went on to define: relapse as the reappearance of symptoms of asthma requiring unscheduled care within three weeks of the initial event, and recurrence as the reappearance of symptoms of asthma requiring unscheduled care more than three weeks after the initial event (*Camargo, 2003*).

Although a number of variables were significantly associated with relapse according to the univariate analysis with a Cox proportional hazards model

(based on a p value of 0.2.), including variables for access to a spacer, access to a peak flow meter (PFM); having ever received asthma education from a health professional; having ever been hospitalized; frequency of hospitalization in the last 12 months; having ever gone to an emergency room for urgent treatment of asthma symptoms in last 12 months, frequency of emergency room visits for urgent treatment of asthma symptoms; and appropriateness of asthma treatment in the multivariate Cox proportional hazards model selection, but only one variable was retained in the final model: the frequency of hospitalization for asthma treatment in the last 12 months. With asthma severity in the model, the hazard ratio is 3.1 (95% CI 1.1-8.6) if the patient had 1 hospitalization in the last 12 months. When the patient had 2 or more hospitalization, the hazard ratio increased to 3.3 (95% CI 1.4-7.8). When asthma severity was excluded from the model, the hazard ratio declined slightly to 2.5 (95% CI 1.0-6.7) if the patient had 1 hospitalization in the last 12 months, but increased to 4.1 (95% CI 1.8-9.2) if the patient had 2 or more hospitalizations.

Some of the difficulties in assessing and limiting asthma relapse reflects an incomplete understanding of the factors that lead to ED visits. Patients present with a variety of symptoms and in conditions that range from mild to severe respiratory distress. It is understandable that studies addressing heterogeneous groups of patients may have conflicting results. Larger-scale

studies may have greater power to identify the risk factors, allowing for recommendations for tailored therapy or other interventions such education.

Further research should decrease asthma exacerbations and relapse, and focus on the practicality of identifying higher-risk patients for a variety of interventions. These include referral to an asthma specialist, efforts to improve the management of asthma patients by primary care physicians, the efforts to control the home environment, finally the efficacy of tailoring anti-inflammatory and other medication interventions following ED treatment for acute asthma.

3. Proxy or marker variables of underlying asthma severity

In our analysis, spacer use, peak flow meter (PFM) use, having an asthma management plan(AMP), and having ever received asthma education from a health professional were regarded as potential marker variables of asthma severity. Use of PFM, spacer, and AMP would be expected to be higher in patients with greater disease severity who would also be expected to have a higher risk of relapse. Individuals using a spacer, or PFM or AMP would therefore tend to have a higher risk for later relapse as shown previously in table 7.

In the first model selection approach, we included all of these marker variables. At a significance level of 5%, the final model included only one significant risk factor: the frequency of hospitalization in the last 12 months. This was true regardless of whether we included asthma severity or not in the model. At a significance level of 10%, when we included asthma severity, the final model included two significant risk factors: use of a spacer and the frequency of hospitalization in the last 12 months. When asthma severity was not included in the modeling process, the final model included three significant risk factors: use of a spacer, having received asthma education, and frequency of hospitalization in the last 12 months.

In the second set of model selections, we excluded all marker variables. Regardless of whether we considered asthma severity, the final model again included only one significant risk factor at significance levels of both 5% and 10%: the frequency of hospitalization in the last 12 months and thus result did not change when the significance level for variable inclusion was increased from 5 to 10%.

The decision was based on an understanding or conceptual model of disease severity and ED use, the marker variables mentioned above are expected to be indicators of asthma severity, not possible risk factors for later asthma relapse. It is reasonable that they are not in the model selection.

4. Asthma severity as a factor for relapse

Asthma is a common disease with great variation in both severity and etiology. Since there is no agreed-upon "gold standard" for assessing asthma severity, this variability leads to problems for both diagnosis and treatment. More valid assessments of asthma severity are needed, particularly for asthma research.

In our study, the degree of asthma severity over the last 4 weeks did not predict asthma relapse as much as expected. The Hazard Ratio for mild persistent and mild intermittent asthma patients are 1.1 and 0.5, respectively, compared to the combination group of severe and moderate persistent asthma patients. This could be because the sample size in this study is relatively small, asthma subjects in our cohort are mostly intermittent or mild persistent (110/138, or 80%), and we had almost no subjects with severe persistent asthma. When the severity was excluded from the multivariate model, there was no significant effect on the final model selection. It is as reasonable, therefore, to use the final model without asthma severity included, as the model with asthma severity included.

4. Implications for disease management

The consistent pattern of relapse during the study suggests that many

patients who have more than 1 hospitalization in the last 12 months before the current asthma ED visit are predisposed to further urgent asthma care (relapse). In our study, patients, with prior hospitalization were between 2.5 and 3 times more likely to relapse over 6 months follow up period. Since prior hospitalization is probably not a true causal factor, patients with prior hospitalization needs more attention both by clinician and themselves, and it may be a targeted risk group. Thus a future study should focus on this group of high-risk asthma patients who had hospitalization in the previous twelve month and develop more aggressive therapeutic regimen in order to reduce the relapse rate among this population, according to the guidelines for the diagnosis and management of asthma (*National Institute of Health, 1997*).

5. Limitation of the study

There are several limitations to this study. First, approximately 20% of the patients were lost to follow-up at 26 weeks, including both those unable to contact and those who declined to participate in the follow-up calls. We have no information to estimate whether their relapse rate would be different from those patients for whom we had follow-up, and we treated all those patients as censored individuals. Second, we relied on patients' self-reported information. It is possible that patients may have under-reported these factors, e.g. smoking status, treatment appropriateness, out of embarrassment of continued behavior they knew to be detrimental to their

asthma management. Also, as this is an observational study, many other unrecognized factors such as behavior and personality can affect the data collection. Thirdly, there is a limited sample size, which causes model estimates to be unstable. Fourthly, there is no consistent definition of relapse in the literature. The definition of relapse in our study is restricted to urgent asthma treatment, or ED visit. Different definition of asthma relapse may have different survival analysis that we currently did. Finally, the severity of asthma patients in this study were mostly mild intermittent or mild persistent, which leads to a lower rate of relapse, possibly explaining why asthma severity does not at all predict relapse in our study, as expected but there was not a large difference in relapse rate across severity groups.

Many other factors that influence relapse (e.g., patient environment, self-care, biological factors) that could be assessed in the course of care in the ED, were not included in our study.

6. Conclusions

One factor, the frequency of hospitalization in the last 12 months, was identified as contributing to asthma relapse within the period of 26 weeks. This finding could help clinicians identify higher risk asthma patients and provide therapy more effective in preventing future asthma exacerbation.

Appendix A

ADULT COHORT VISIT FORM

Emergency Department (CIRCLE ONE): **Gerber   Blodgett   Butterworth**

ED visit date (*mm/dd/yyyy*) .... |__|__| / |__|__| / |__|__|__|__|

ED triage time (*military- hh:mm*) .... |__|__| : |__|__|

Insurance Company ...._____

Presenting complaint ...._____

PLEASE ANSWER EVERY QUESTION. IF SUBJECT DOES NOT KNOW AN ANSWER PLEASE WRITE IN 'DK' (DON'T KNOW). RECORD ONLY ONE ANSWER TO EACH QUESTION UNLESS SPECIFICALLY INSTRUCTED TO SELECT ONE OR MORE.

A. DEMOGRAPHIC INFORMATION

1. What is your date of birth (*mm/dd/yyyy*) |__|__| / |__|__| / |__|__|__|__|

2. Sex: Male.. 01
           Female.. 02

3. Are you Spanish, Hispanic or Latino?
        No 01
        Yes.. 02

4. What is your race? (SELECT ONE OR MORE)

        White or Caucasian 01
        Black or African-American 02
        Asian.. 03
        American Indian or Alaska Native.................................... 04
        Native Hawaiian or Pacific Islander 05
        Other race (*specify* ....06)

5. How much schooling have you completed?

        Less than high school 01
        Graduated high school or got GED 02
        1-3 years of college 03
        4-year college degree or more.. 04

B. ASTHMA HISTORY

6. Have you <u>ever</u> been told by a doctor, nurse, or other health professional that you had asthma?

No 01
Yes... 02

If Yes,
6a. How old were you when you were first told by a
doctor, nurse, or other health professional that you
had asthma?

(*years old*)... |__|__|

6b. Has a doctor, nurse, or other health professional
ever said what the cause of your asthma was?

No 01
Yes (*specify:* 02

6c. Do certain things, exposures, or activities make your asthma worse?

No 01
Yes (*specify:*.. 02

IF AGE AT <u>FIRST</u> DIAGNOSIS ≥15 YEARS then (ELSE SKIP TO QU 7):
6d. Were you ever told by a doctor or other medical person that your
asthma was related to any <u>job</u> you ever had? (IF INITIAL RESPONSE
IS NO, ASK AHAVE YOU EVER HAD A JOB OUTSIDE THE HOME?")
No 01
Yes (SKIP TO QUESTION 6f) 02
Never worked outside the home (SKIP TO QUESTION 7)...... 03

6e. Did <u>you</u> ever tell a doctor or other medical person that your asthma
was related to any job you ever had?
No 01
Yes... 02

6f. When you <u>first</u> developed symptoms of asthma, what kind of work were you
doing? For example, RN, clerical, managerial, teaching, auto mechanic, or
accountant.
(*specify:* _____

IF NOT WORKING WHEN ASTHMA STARTED (SKIP TO QUESTION 7)

6g. What kind of business or industry was that job in? For example,
hospital, newspaper publishing, mail order house, auto repair shop, or
bank.

(specify: _____)

The following questions are about your asthma symptoms <u>over the last 4 weeks</u> that is from _____ to _____ (but <u>do not</u> refer to this <u>current</u> episode)

7. How often in the last 4 weeks have you had asthma symptoms <u>during the day</u>? (i.e., wheezing, a dry cough, shortness of breath, and/or chest tightness due to asthma)

   Never 01
   Less than once a week 02
   1 or 2 times a week.. 03
   3 to 6 times a week.. 04
   Every day... 05
   Continually (all the time) 06

8. How many times over the last 4 weeks did you <u>wake up at night</u> because of asthma symptoms? (i.e., wheezing, a dry cough, SOB, and/or chest tightness due to asthma)

   Never 01
   1 or 2 times 02
   3 to 4 times 03
   5 to 9 times 04
   10 or more times... 05

9. How many times over the last 4 weeks have your activities been <u>affected or restricted</u> by asthma symptoms?

   Never 01
   1 or 2 times... 02
   3 to 4 times... 03
   5 or more times... 04
   All the time.. 05

10. In the last 4 weeks have your asthma symptoms ever been severe enough to limit your speech to <u>only 1 or 2 words</u> at a time between breaths?

    No 01
    Yes 02

    If Yes, 10a. How many times has this occurred in the last 4 weeks?

    (times)... |__|__|
    (NOTE = THE NUMBER OF SEPERATE EPISODES)

C. USUAL SOURCE OF ASTHMA CARE

11. Do you have a "primary care provider" or other regular source of medical care (such as a family doctor, internist, PA, nurse practitioner or medical clinic)?

No   (IF NO, SKIP TO QUESTION 13) 01
Yes 02

12. Does this doctor/provider/clinic take <u>primary responsibility</u> for your regular <u>asthma care</u>? (i.e., directs your asthma care and writes most of your prescriptions)
[= REGULAR ASTHMA CARE PROVIDER]

No 01
Yes   (IF YES, SKIP TO QUESTION 14) 02

13. What type of doctor/provider/clinic takes <u>primary responsibility</u> for your regular <u>asthma care</u>? (i.e., directs your asthma care and writes most of your prescriptions)
[= REGULAR ASTHMA CARE PROVIDER]
Emergency Department (*specify:* _____) 01
Med center (= urgent care center) (*specify:* _____) ... 02
An asthma specialist (*specify pulmonologist, allergist,*
or asthma clinic _____) 03
Other provider/site (*specify:* _____)04
No regular asthma care provider **(SKIP TO QUESTION 16)** ... 05

14. How many times in the last 12 months did you visit <u>this</u> (doctor/provider/clinic) for a <u>regularly scheduled appointment</u> for asthma care?
[SCHEDULED APPT. = REGULAR OR ROUTINE VISIT TO DISCUSS ASTHMA]

(*times or '0' for Never*) .... |__|__|

15. How many months ago was the last <u>regularly scheduled appointment</u> for asthma care with this doctor/provider/clinic?

≤ 1 month ago 01
1 – 3 months ago 02
4 - 6 months ago 03
7 – 12 months ago 04
> 12 months ago 05

16. In the last 12 months, have you visited an <u>asthma specialist</u> (e.g., pulmonologist, allergist, asthma clinic or other specialist)? (LEAVE BLANK IF SPECIALIST IS REGULAR ASTHMA CARE PROVIDER AS DEFINED IN QUESTION 13).

No 01

Yes 02

D. CURRENT ASTHMA TREATMENT, MANAGEMENT AND CONTROL

17. RECORD ALL PRESCRIPTION AND NON-PRESCRIPTION ASTHMA RELATED MEDICATIONS USED IN THE LAST 4 WEEKS IN THE FOLLOWING TABLE (EXCEPT SYSTEMIC STEROIDS – SEE QUESTION 18)

Medication	Frequency Doctor Rx'd	Current Frequency of Use	Route	Has Rx Run Out?	Used in last four weeks?
	Daily QOD Wkly PRN	Daily QOD Wkly PRN	PO Inh Neb	Yes No	Yes No
	Daily QOD Wkly PRN	Daily QOD Wkly PRN	PO Inh Neb	Yes No	Yes No
	Daily QOD Wkly PRN	Daily QOD Wkly PRN	PO Inh Neb	Yes No	Yes No
	Daily QOD Wkly PRN	Daily QOD Wkly PRN	PO Inh Neb	Yes No	Yes No
	Daily QOD Wkly PRN	Daily QOD Wkly PRN	PO Inh Neb	Yes No	Yes No
	Daily QOD Wkly PRN	Daily QOD Wkly PRN	PO Inh Neb	Yes No	Yes No
	Daily QOD Wkly PRN	Daily QOD Wkly PRN	PO Inh Neb	Yes No	Yes No

18. Have you <u>ever</u> taken steroids orally or by injection for a severe asthma attack?

No 01

Yes 02

If Yes, 18a. <u>Over the past 4 weeks</u>, have you taken any <u>steroids</u> orally or by injection for asthma? (CHECK ORAL AND INJECTION IF HAVE TAKEN BOTH)

No   01
Yes – Injection   02
Yes – Oral   03

If Yes - Oral,

18b. How many days in the past 4 weeks did you take oral steroids? |__|__|

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18c. How many days ago did you last take oral steroids? (*days*) |__|__|

IF __NOT__ CURRENTLY USING INHALED CORTICOSTEROIDS:

19. Have you __ever__ used an __inhaled steroid__ for asthma?

No 01
Yes.. 02

If Yes, 19a. Names (s) _____

19b. For how long did you take an inhaled steroid for asthma?|__|__|
days.........01
weeks......02
*months ago*03

19c. When did you last use an inhaled steroid for asthma? ... |__|__|
*weeks*01
months.....02
years ago. 03

20. Are you usually able to get your asthma prescriptions filled?

No 01
Yes.. 02

If No, 20a. Why not? Specify main reason

_____ ....

21. A __spacer__ is a device that you put between the mouth and inhaler to make it easier to breathe medicine into the lungs. Do you have a spacer?

No 01
Yes.. 02

If Yes, 21a. How often do you use the spacer when using the inhaler?

Never 01
Rarely 02
Occasionally 03
Usually.. 04
Always 05

22. A __peak flow meter__ measures how hard you can blow air out of the lungs. Do you have a peak flow meter?

No 01
Yes.. 02

If Yes, 22a. On average, how often do you use the peak flow meter?

```
Rarely ................................................................ 01
< 1/week ............................................................ 02
1-3/week ........................................................... 03
4-6/week ........................................................... 04
Daily ................................................................... 05
Only during exacerbations ................................ 06
```

23. Has a doctor or a nurse ever given you a <u>written plan</u> for you to treat your asthma?
     [= ASTHMA MANAGEMENT PLAN]

```
     No ................................................................ 01
     Yes .............................................................. 02
```

24. Have you ever received <u>education</u> about asthma control and treatment from a health professional?

```
     No ................................................................ 01
     Yes .............................................................. 02
```

If Yes, 24a. What did you learn about? (<u>CIRCLE</u> YES OR NO FOR EACH ITEM):

```
     Things that can trigger your asthma? .......... YES          NO
     Medications and treatments? ..................... YES          NO
     How to use an inhaler or nebulizer?  ........... YES          NO
     How to use a peak flow meter? .................. YES          NO
     What to do during an asthma attack?  ......... YES          NO
     How to use a written action plan?  .............. YES          NO
```

E. EMERGENCY ASTHMA CARE

[THE FOLLOWING ANSWERS SHOULD <u>NOT</u> INCLUDE THE CURRENT EPISODE]

25. Have you <u>ever</u> been <u>hospitalized</u> overnight for treatment of asthma symptoms [i.e., wheezing, dry cough, shortness of breath, and/or chest tightness due to asthma]?

```
     No ................................................................ 01
     Yes .............................................................. 02
```

If Yes,
25a. How many times <u>in the last 12 months</u>, have <u>you</u>
     <u>stayed over night in the hospital</u> for treatment of
     asthma symptoms? (*times*) .... |__|__|

26. Excluding today, have you ever previously gone to an emergency room for urgent treatment of asthma symptoms?

No 01
Yes... 02

If Yes,
26a. How many times in the last 12 months, have you visited an emergency room for urgent treatment of asthma symptoms?(*times*)............. |__|__|

26b. Which emergency rooms did you visit?_____

26c. How long ago was the last visit? .... |__|__|
days.........01
weeks 02
*months ago*03

27. When you are having <u>problems</u> with asthma symptoms that require <u>urgent</u> treatment - that is, treatment needed within 24 hours of recognizing a problem, where do you <u>usually</u> end up going?

Regular asthma care provider (*as defined previously*)
    SKIP TO QUESTION 28 01
Emergency Department (*if after hours or RACP is NA*)........... 02
    (*specify:* _____
Emergency department (ALL times) *specify:* _____ 03
Med care center (*specify:* _____).............. 04
An asthma specialist (*specify pulmonologist, allergist,*
    or asthma clinic: _____).................... 05
Other provider/site (*specify:* _____ 06
No specific location/provider 07

If answer is <u>NOT</u> regular asthma care provider then:

27a. Why do you use this particular place for asthma care? (CHECK ALL THAT APPLY)

No regular asthma care provider 01
Regular asthma care provider not available............................ 02
Insurance company dictates 03
No insurance... 04
Other cost issues (*specify:* __ _____ 05
Transport issues (*specify:* _____ 06
Convenience.. 07
Best medical care 08
Past experience/comfort with people/place............................ 09
Other (*specify:* 10

28. How many times in the last 12 months did you visit a <u>doctor's office</u> or <u>clinic</u> for urgent treatment of asthma symptoms? [URGENT VISIT = NOT SCHEDULED OR SCHEDULED < 24 HRS AHEAD OF TIME. DO NOT INCLUDE ED OR HOSPITAL VISITS]

   (*times or '0' for never*)... |__|__|

F. SMOKING HISTORY

29. Have you ever smoked <u>cigarettes</u>? [IF QUIT SMOKING ≤ 28 DAYS = SMOKER]

Never smoke	01
Former-smoker	02
Current Smoker	03

<u>IF CURRENT SMOKER</u>:

29a. At what age did you first start to smoke regularly?.............__ _____

29b. On average, how many <u>cigarettes</u> do you smoke per day?

<u>IF FORMER SMOKER</u>:

29c. At what age did you first start to smoke regularly? ....

29d. At what age did you QUIT smoking regularly? (yrs. old)......._ _____

29e. On average, how many <u>cigarettes</u> did you smoke per day? _____

G. ASTHMA AWARENESS

Please tell us if the following statements are true or false.

30. Most people with asthma can become free of symptoms with proper treatment.

   True 01
   False...02

31. Asthma is characterized by inflammation of the airways, which if controlled can greatly reduce symptoms.

   True 01
   False...02

32. If someone with asthma feels well, it is okay to stop taking his or her medications.

   True 01
   False...02

Appendix B

ADULT COHORT 2-WEEK FOLLOW-UP FORM

SECTION A: EMERGENCY ASTHMA VISITS

FIRST CONFIRM REGULAR ASTHMA CARE PROVIDER (RACP) INFORMATION:

When we completed the survey during your visit to the emergency department on __/__, we noted that the doctor/provider/clinic that takes <u>primary responsibility</u> for your asthma - that is, directs and writes most of your prescriptions was:

(name)_____

Type of health care provider:
PCP/CLINIC 01
SPECIALIST..02
ED 03
MEDCENTER..04
OTHER...05
NONE 06

---

1.   Is this correct?
         No (Specify who is: _____   01
         Yes 02

2.   Since you left the hospital emergency department on |__|__|
     / |__|__| / |__|__|, have you had a worsening of your asthma
     that led you to go for <u>urgent</u> medical treatment?
         No..01
         Yes 02

3.   How many times has this happened since you left the
     emergency department?

         (times) ....|__|__|

4.   Thinking about the <u>first time</u> this happened, when
     did you go for <u>urgent</u> medical treatment for your
     asthma?
         (mm/dd/yr)............................... |__|__| / |__|__| / |__|__|

5.   Where did you <u>first</u> go for this <u>urgent</u> asthma visit?
         Regular asthma care provider (as defined above)...............................01

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Med care center (specify:____ _____ 03
An asthma specialist: pulmonologist 04
An asthma specialist: allergist.......................................05
An asthma specialist: asthma clinic.................................06
Other provider/site (specify: _____ _____07
No specific location/provider..08

5a. Why did you use this particular place for asthma care?
     (CHECK ALL THAT APPLY)
          No regular asthma care provider............................... 01
          Regular asthma care provider not available 02
          Insurance company dictates...................................03
          No insurance 04
          Other cost issues (specify: _____ _____ 05
          Transport issues (specify: _____ 06
          Convenience 07
          Best medical care...08
          Past experience/comfort with people/place...........09
          Other (specify: _____ _____......10
          Severity of episode – EMERGENCY!...................11

6.   At this visit did the doctor change your asthma
       medicines or make any other changes in the
       management of your asthma? (PROMPT – FOR
       EXAMPLE, GIVE YOU A NEW MEDICATION, OR
       CHANGE THE WAY YOU USE YOUR EXISITING
       MEDICATIONS, OR CHANGE THE WAY YOU
       MONITOR OR MANAGE YOUR ASTHMA)
          No asthma treatment given (including no inhaled ß-agonist)......01
          Given inhaled ß-agonist treatment but no new asthma Rx 02
          Change in treatment plan (specify below)................03

       Details_____

7.   Did this visit result in you being transferred to an emergency department
or hospital?
          No...01
          Yes (Specify ED: _____ _02

       If Yes, 7a. Were you admitted to the hospital overnight?
          No...01
          Yes (Specify hospital: _____ _____ 02

IF Q3 = MORE THAN ONE "RELAPSE" VISIT — REPEAT QUESTIONS FOR
SECOND VISIT SINCE PATIENT LEFT HOSPITAL. AT END OF THIS

SECTION CONFIRM SINCE PATIENT FIRST LEFT EMERGENCY
DEPARTMENT:

Total (cumulative) number of ED/Urgent Care visits ....|___|___|

Total (cumulative) number of overnight hospitalizations ....|___|___|

SECTION B: ROUTINE ASTHMA VISITS

8. Since you left the hospital emergency department on
    ___/__ have you made a follow-up appointment with
    your regular asthma care provider (RACP) for an
    asthma check up?
    No..01
    Yes 02

8a. When did you first see this doctor/nurse/clinic (RACP) for an asthma
check-up?
    (mm/dd/yr)................................ |___|___| / |___|___| / |___|___|
    or number of days after ED visit (days) ....|___|___|___|

8b. How many asthma check-ups have you had with this
    doctor/nurse/clinic (RACP) since he/she left the
    emergency department?
    (number of checkups)...|___|___|

8c. As a result of this visit (these visits), did the doctor change
    your asthma medicines or make any other changes in the
    management of his/her asthma? (PROMPT – NEW
    MEDS?, OR CHANGE EXISITING MEDS?, OR CHANGE
    IN MANAGEMENT OF ASTHMA?)
    No..01
    Yes 02

    Describe: _____

9. Have you had any other doctor visits specifically related to
    your asthma care and treatment since leaving the
    emergency department? (i.e., NOT WITH RACP, e.g.,
    ASTHMA SPECIALISTS)
    No..01
    Yes 02

9a. When did you first see ANOTHER doctor/nurse/clinic
    NOT RACP for an asthma related visit?
    (mm/dd/yr)................................. |___|___| / |___|___| / |___|___|
    or number of days after ED visit (days) ....|___|___|___|

9b. How many <u>asthma related visits</u> have you had with ANOTHER doctor/nurse/clinic (*NOT RACP*) since you left the emergency department?

(number of visits)...|___|___|

9c. Where did the visit take place and who was it with? (CHECK MORE THAN ONE RESPONSE IF VISITS TO MORE THAN ONE SPECIALIST)

Asthma specialist (specify type: _____ ___ 01

Specialty Asthma Clinic...02

Other primary care type doctor/clinic.....................................03

Other (specify: _____ 04

Name & location _____

9d. What was the primary purpose of this (these) visit(s)?

(Describe: _____

9e. As a result of this (these) visit(s), did the doctor change your asthma medicines or make any other changes in the management of his/her asthma? (PROMPT – NEW MEDS?, OR CHANGE EXISITING MEDS?, OR CHANGE IN MANAGEMENT OF ASTHMA?)

No...01
Yes 02

Describe: _____

10. Have you had any other doctor visits for health problems <u>not related to asthma</u> since he/she left the hospital? (# visits).......................................|___|___|

If Yes, 10a. What was visit for? _____

C. ORAL STEROIDS TREATMENT AND COMPLIANCE

[SEE FRONT PAGE OF THIS FORM — *ONLY* ASK QUESTION 10 IF PATIENT <u>SENT HOME</u> FROM ED ON SHORT-TERM <u>ORAL STEROID</u> REGIMEN]:

<u>ORAL steroid:</u>
When you left the emergency department, you were advised to take an oral steroid medicine called _____ for ___ days.

11. How many days did you actually take this medicine? (days) ...|___|___|

11a. Was this fewer days than originally prescribed?

No 01
Yes 02

11b. Please think about why you did not take the _____ as prescribed. As I read you the following list, please let me know <u>every</u> reason that applies to you. (CIRCLE <u>ALL</u> THAT APPLY):

I felt better and I didn't feel it was necessary 01
I experienced side effects. [real or imagined] 02
I was scared about possible side effects 03
The treatment plan was too complicated 04
I had no money to fill prescription 05
I lost the prescription 06
I refused to take medicine 07
Doctor changed treatment 08
Other (Specify: _____ 09

IF MULTIPLE RESPONSES ASK 11C. ELSE GO TO 12:

11c. Which was the <u>most important reason</u> that
you did not take the _____ as
prescribed? (Q11b code ##) .... |___|___|

D. CURRENT SYMPTOMS, CONTROL AND QUALITY OF LIFE

12. How often in the last 2 weeks have you had asthma symptoms <u>during the day</u>? (i.e., wheezing, a dry cough, shortness of breath, and/or chest tightness r/t asthma)

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

13. How many times over the last 2 weeks did you <u>wake up at night</u> because of asthma symptoms? (i.e., wheezing, a dry cough, shortness of breath, and/or chest tightness r/t asthma)

Never 01
1 or 2 times 02
3 to 4 times 03
5 to 9 times 04
10 or more times 05

14. How many times over the last 2 weeks have your activities been <u>affected or restricted</u> by asthma symptoms?

Never	01
1 or 2 times	02
3 to 4 times	03
5 or more times	04
All the time	05

15. Over the past 2 weeks have your asthma symptoms been severe enough to limit your speech to <u>only 1 or 2 words</u> at a time between breaths?

No	01
Yes	02

15a. How many times has this occurred in the last 2 weeks? .... |___|___|

16. Over the past 2 weeks how many days have you used your quick relief medicine. (i.e., short acting bronchodilator or rescue medicine)

(days) .... |___|___|

17. Over the past 2 weeks, how <u>much</u> discomfort or distress have you felt because of asthma symptoms? Would you say…

None	01
Mild	02
Moderate	03
Severe	04

18. How would you rate your <u>asthma condition now</u> compared to when you first <u>arrived</u> to the emergency department?

Much worse	01
A little worse	02
About the same	03
A little better	04
Much better	05

19. Over the past 2 weeks how often did you use your peak flow meter?

None	01
< 1/week	02
1-3/week	03
4-6/week	04
Daily	05
Only during exacerbations	06
Doesn't have a PFM	07

19a. Over the past 2 weeks, what were your highest and lowest peak flow readings?

Highest reading (liters/minute)..

Lowest reading (liters/minute) .... |___|___|___|

19b. Over the past 2 weeks, has the peak flow dropped below 80% of your personnel best

No...01

Yes 02

19c. What did you do when this occurred?

Details: _____

Appendix C

6-MONTH ADULT COHORT FOLLOW-UP FORM

SECTION A: EMERGENCY ASTHMA VISITS

1. Is the above information correct?
   No (What data is incorrect?: _____ _____ .01
   Yes 02

2. Since we last talked to you on |__|__| / |__|__| , have you
   had a worsening of asthma that required *urgent* medical
   treatment?
   No...01
   Yes 02

3. How many times has this happened since we last talked
   to you?

   (times) ....|__|__|

4. Thinking about the first time this happened since we
   last talked to you.   When did you go for urgent medical
   treatment for your asthma?
   (mm/dd)...|__|__| / |__|__|

5. Where did you first go for this urgent asthma visit?
   Regular asthma care provider (as defined above)...........................01
   Hospital ED (specify: _____ 02
   Med care center (specify: _____ _____ 03
   An asthma specialist: pulmonologist 04
   An asthma specialist: allergist....................................05
   An asthma specialist: asthma clinic................................06
   Other provider/site (specify: _____ _____ 07
   No specific location/provider 08

5a. Why did you use this particular place for asthma care?
    (CHECK ALL THAT APPLY)
    No regular asthma care provider............................. 01
    Regular asthma care provider not available 02
    Insurance company dictates..03
    No insurance...04
    Other cost issues (specify: ____ _____ 05
    Transport issues (specify: _____ _____06
    Convenience 07
    Best medical care 08
    Past experience/comfort with people/place 09
    Other (specify: _____ _____ 10
    Severity of episode – EMERGENCY!..............................11

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6. At this visit did the doctor change your asthma
   medicines or make any other changes in the
   management of your asthma? (PROMPT – FOR
   EXAMPLE, GIVE YOU A NEW MEDICATION, OR

   CHANGE THE WAY YOU USE YOUR EXISTING
   MEDICATIONS, OR CHANGE THE WAY YOU MONITOR
   OR MANAGE YOUR ASTHMA)

No asthma treatment given (including no inhaled ß-agonist)	01
Given inhaled ß-agonist treatment but no new asthma Rx	02
Change in treatment plan (specify below)	03
Change in treatment plan (specify below) then transferred to ED	04

   Details_____

   _____

7. Were you transferred to an emergency department or hospital as a result
   of this visit?

No...01	
Yes (Specify ED: _____ 02	

   If Yes, 7a. Were you admitted to the hospital overnight?

No...01	
Yes (Specify hospital: _____02	

IF Q3 = MORE THAN ONE "RELAPSE" VISIT — REPEAT QUESTIONS FOR
SECOND VISIT SINCE 2-WEEK FU CALL COMPLETED. AT END OF THIS
SECTION CONFIRM SINCE 2-WEEK FU CALL:

   Total (cumulative) number of ED/Urgent Care visits ....|___|___|

   Total (cumulative) number of overnight hospitalizations ....|___|___|

SECTION B: ROUTINE ASTHMA VISITS

**IF PERSON HAD NOT YET SEEN RACP AT 2-WEEK FU CALL FOR
FOLLOW-UP VISIT**

8. When did you first see this doctor/nurse/clinic (RACP) for a **follow-up asthma
check-up**?

   (mm/dd)...|___|___| / |___|___|

   or number of days after ED visit (days) ....|___|___|___|

8a. Since we last talked to you, have you seen your regular
    asthma care provider (RACP) again for a **routine
    asthma check up**?

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No	01
Yes	02

8b. How many **routine** asthma check-ups have you had with this doctor/nurse/ clinic (*RACP*) since we last talked to you?

(number of checkups)...|___|___|

8c. As a result of this visit (these visits), did your doctor change your asthma medicines or make any other changes in your asthma management plan? (PROMPT – NEW MEDS?, OR CHANGE EXISTING MEDS?, OR CHANGE IN MANAGEMENT OF ASTHMA?)

No..01

Yes 02

Describe: _____

9. Have you had **any other** doctor visits specifically related to your asthma care and treatment since we last talked to you on __ / __ ? (i.e., NOT WITH RACP, e.g., ASTHMA SPECIALISTS)

No..01

Yes 02

9a. When did you **first** see ANOTHER doctor/nurse/clinic (*NOT RACP*) for an **asthma-related visit**?

(mm/dd)...|___|___|/|___|___|

or number of days after ED visit (days).................|___|___|___|

NOT APPLICABLE (first visit recorded at 2-WK FU call).........99

9b. How many **asthma-related visits** have you had with ANOTHER doctor/nurse/clinic (*NOT RACP*) since we last talked to you?

(number of visits)...|___|___|

9c. Where did the visit take place and who was it with? (CHECK MORE THAN ONE RESPONSE IF VISITS TO MORE THAN ONE SPECIALIST)

Asthma specialist (specify type: _____01

Specialty Asthma Clinic.......................................02

Other primary care type doctor/clinic.......................03

Other (specify: _____ _____ 04

Name & location _____

9d. What was the primary purpose of this (these) visit(s)?
Describe: _____

9e. As a result of this (these) visit(s), did your doctor change your asthma medicines or make any other changes in your asthma management plan? (PROMPT – NEW MEDS?, OR CHANGE EXISTING MEDS?, OR CHANGE IN MANAGEMENT OF ASTHMA?)

No...01
Yes 02

Describe: _____

10. Have you had any other doctor visits for health problems not related to asthma since we last talked to you on __/__? (# visits) ....|__|__|

If Yes,
10a. What was visit for? _____

C. CURRENT ASTHMA-RELATED MEDICATIONS

11. RECORD ALL PRESCRIPTION AND NON-PRESCRIPTION ASTHMA-RELATED MEDICATIONS USED IN THE LAST 6 MONTHS IN THE FOLLOWING TABLE (EXCEPT SYSTEMIC STEROIDS – SEE QUESTION 11a)

Medication (name)	Frequency Doctor Rx'd	Current Frequency of Use	Route	Time period of use (months) (→ most recent)
	Daily QOD weekly PRN	Daily QOD Weekly PRN	PO Inh Neb	1 2 3 4 5 6
	Daily QOD weekly PRN	Daily QOD Weekly PRN	PO Inh Neb	1 2 3 4 5 6
	Daily QOD weekly PRN	Daily QOD Weekly PRN	PO Inh Neb	1 2 3 4 5 6
	Daily QOD weekly PRN	Daily QOD Weekly PRN	PO Inh Neb	1 2 3 4 5 6
	Daily QOD weekly PRN	Daily QOD Weekly PRN	PO Inh Neb	1 2 3 4 5 6
	Daily QOD weekly PRN	Daily QOD Weekly PRN	PO Inh Neb	1 2 3 4 5 6
	Daily QOD weekly PRN	Daily QOD Weekly PRN	PO Inh Neb	1 2 3 4 5 6

COMMENTS: _____ _____

11a. **Over the past 6 months,** have you taken any <u>steroids</u> orally or by injection for asthma? (CHECK ORAL AND INJECTION IF HAVE TAKEN BOTH)

        No... 01
        Yes – Injection 02
        Yes – Oral...03
        Yes – Injection & oral........................04

If Yes - Oral,

 11b. How many rounds of oral steroids have you taken over the last 6 months? _

__ __ rounds

      11c. How long ago was the last round of oral steroids? ____ days / weeks ago

D. CURRENT SYMPTOMS, CONTROL AND QUALITY OF LIFE

12.   How often in the last 4 weeks have you had asthma symptoms <u>during the day</u>? (i.e., wheezing, a dry cough, shortness of breath, and/or chest tightness)
        Never..01
        Less than once a week...................................02
        1 or 2 times a week 03
        3 to 6 times a week 04
        Every day 05
        Continually (all the time)................................06

13.   How many times over the last 4 weeks did you <u>wake up at night</u> because of asthma symptoms? (i.e., wheezing, a dry cough, shortness of breath, and/or chest tightness)
        Never..01
        1 or 2 times...02
        3 to 4 times...03
        5 to 9 times...04
        10 or more times 05

14.   How many times over the last 4 weeks have your activities been <u>affected or restricted</u> by asthma symptoms?
        Never..01
        1 or 2 times...02
        3 to 4 times...03
        5 or more times 04
        All the time..05

15. Over the past 4 weeks have your asthma symptoms been severe enough to limit your speech to <u>only 1 or 2 words</u> at a time between breaths?

    No...01

    Yes 02

If Yes,

    15a. How many times has this occurred in the last 4 weeks?.|___|___|

16. Over the past 4 weeks how many days have you had to use your quick relief medicine (i.e., short acting bronchodilator or rescue medicine)?

    (days) ....|___|___|

17. Over the past 4 weeks, how <u>much</u> discomfort or distress have you felt because of asthma symptoms? Would you say...(READ RESPONSES)

    None...01

    Mild..02

    Moderate 03

    Severe..04

18. How would you rate your <u>asthma condition now</u> compared to around the <u>time period</u> when you went to the emergency department on __ / __?

    Much worse 01

    A little worse 02

    About the same 03

    A little better 04

    Much better 05

19. Over the past 4 weeks how often did you use your peak flow meter?

    None...01

    < 1/week..02

    1-3/week..03

    4-6/week..04

    Daily 05

    Only during exacerbations....................................06

    Don't have a PFM...07

19a. What is your personal best peak flow reading? (liters/minute)

    |___|___|___|

19b. Over the past 4 weeks, what were the highest and lowest peak flow readings?

    Highest reading (liters/minute)...........................|___|___|___|

    Lowest reading (liters/minute) ....|___|___|___|

19c.   Over the past 4 weeks, has the peak flow dropped below 80% of your personal best?

    No...01
    Yes 02

If Yes,

    19d.   What did you do when this occurred?

    Details:

_____

20.   A <u>spacer</u> is a device that you put between the mouth and inhaler to make it easier
    to breathe medicine into the lungs. Do you have a spacer?

        No...01
        Yes.. 02

If Yes,
    20a. Over the past 4 weeks, how often have you used the spacer when using the inhaler?

        Never..01
        Rarely 02
        Occasionally 03
        Usually.. 04
        Always 05

21. Have you received any **asthma education since** your initial ED visit?

        No...01
            Yes...
        .02
If Yes, 21a. What was the source of this education? – that is, who provided it?

        Your regular asthma care provider 01
        Asthma specialist (allergist, or pulmonologist)......................... 02
        ED or Urgent Care Center
03
        Asthma Coalition
04
        Other health professional (Specify ____ _____)
05
            [SPECIFY TYPE OF PROFESSIONAL AND ORGANIZATION
            e.g., RN-SCHOOL, RN-COMMUNTY)

    21b. What did you learn about? (Circle Yes or No for each item)

    Things that can trigger your asthma?   YES   NO

Medications and treatments?	YES	NO
How to use an inhaler or nebulizer?	YES	NO
How to use a peak flow meter?	YES	NO
What to do during an asthma attack?	YES	NO
How to use a written action plan?	YES	NO

22. Did you have an asthma management plan at the time of the initial ED visit?

No.. 01
        Yes...
..02

If No, 22a. Do you have an asthma management plan now?

No.. 01
Yes...02

23. How confident do you feel about your ability to:

23a. Manage your asthma on a day-to-day basis? (READ AND CIRCLE ONE)

Very unsure	Somewhat unsure	Somewhat confident	Very confident	Don't know
1	2	3	4	5

23b. Manage or control an asthma attack or exacerbation? (READ AND CIRCLE ONE)

Very unsure	Somewhat unsure	Somewhat confident	Very confident	Don't know
1	2	3	4	5

24. If you had an asthma attack today, how likely are you to do the following?

24a. Measure the asthma severity using a PFM (READ AND CIRCLE ONE)

Definitely Yes	Probably Yes	Probably Not	Definitely NOT	Don't know
1	2	3	4	5

24b. Increase the amount of rescue medication (albuterol) (either dose or freq) (READ AND CIRCLE ONE)

Definitely Yes	Probably Yes	Probably Not	Definitely NOT	Don't know
1	2	3	4	5

24c. Wait to see if the symptoms subside after using the medication before calling your doctor or going to the ED (READ AND CIRCLE ONE)

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Definitely Yes	Probably Yes	Probably Not	Definitely NOT	Don't know
1	2	3	4	5

25. If the symptoms continued to persist what action would you take <u>next</u>?

Call PCP...01
Go directly to ED/Urgent Care - always 02
Go directly to ED/Urgent Care - if after hours and PCP N/A.... 03
Continue with treatment.. 04
Not sure 05
Other (Specify) _____..05

26. What other actions or steps do you think would help you better control and manage your asthma?

_____   _____

E. SMOKING HISTORY

27. Have you ever smoked cigarettes?

No (=Never)..01
Yes..02

If Yes, 27a. Do you smoke now?

No (=Former)   01 to 27b
Yes (=Current)   02 Go to 27d

If <u>Former Smoker</u>:

27b. How long ago did you quit? (Time since QUIT must be > 30 days, else = Current Smoker)

_____months   _____years

If patient quit longer than 6 months ago, END OF INTERVIEW.
If patient quit within the last 6 months ago, then

27c. Why did you quit?

_____

27d. Did you use any of the following products or methods to help you quit? (CIRCLE ALL THAT APPLY)

Nicotine gum 01
Nicotine patch 02
Nicotine Spray..03
Nicotine Inhaler 04
Other doctor prescription drug (e.g., Zyban) 05
Counselling 06
Other (Specify)_____07

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If <u>Current Smoker</u>:
27e. On average, how many cigarettes do you currently smoke a day?

_____cigarettes/day

27f. In the last 6 months, have you tried to quit smoking?
No 01
Yes..02

If Yes, 27g. How many times have you tried to quit?

_____ times

27h. Did you use any of the following products or methods to help you quit? (CIRCLE ALL THAT APPLY)
Nicotine gum 01
Nicotine patch 02
Nicotine Spray..03
Nicotine Inhaler 04
Other doctor prescription drug (e.g., Zyban) 05
Counseling 06
Other (Specify)_____ 07

Appendix D. Included Hospitals

	Blodgett hospital		Butterworth Hospital		Blodgett & Butterworth	
	n	%	n	%	N	%
Total enrollment	52		120		172	
Enrollment Status						
Active (2)	4	7.7	2	1.7	6	3.5
Declined (3)	1	1.9	3	2.5	4	2.3
Complete (4)	39	75.0	95	79.2	134	77.9
Ineligible (5)	0	0.0	0	0.0	0	0.0
Loss to follow-up (6)	8	15.4	20	16.7	28	16.3
Total	52		120		172	
Status at 2-week follow-up						
Complete (4)	43	82.7	107	89.2	150	87.2
Waiting (2)	0	0.0	0	0.0	0	0.0
Overdue (3)	0	0.0	0	0.0	0	0.0
Unable to contact (5)	8	15.4	11	9.2	19	11.0
Declined before 2-week follow-up	1	1.9	2	1.7	3	1.7
Total	52		120		172	
Status at 26-week follow-up						
Complete (4)	42	30.4	96	69.6	138	81.7
Overdue (3)	1	50.0	1	50.0	2	1.2
Unable to contact (5)	8	28.6	20	71.4	28	16.6
Declined after 2-week follow-up	0	0.0	1	100.0	1	0.6
Total	51		118		169	

References

Adams RJ, Smith BJ, Ruffin RE. Factors associated with hospital admissions and repeat emergency department visits for adults with asthma. Thorax 2000;55(7):566-73

American Thoracic Society. Lung function testing: selection of reference values and interpretive strategies. Am Rev Respir Dis 1991; 144: 1202-18.

American thoracic Society. The Diagnosis of Asthma. Am Rev Respir Dis., 1986;136:225-130.

Borish L. The inflammatory theory of asthma. Immunol Invest 1987;16(6):501-32

Burt CW and Knapp ED. Ambulatory care visits for asthma: United States, 1993-1994. Adv Data 277.

Camargo CA. Epidemiology of recurrent asthma exacerbation. National conference on asthma 2003. Meeting the challenge of health people 2010: preventing and controlling asthma, 2003.

Carr, W, Zeitel, L, Weiss, K Variations in asthma hospitalizations and deaths in New York city. *Am J Public Health* 1992; 82,59-65

CDC, National Center for Health Statistics. Asthma prevalence, health care use and mortality, 2000-2001. 2002. Available at http://www.cdc.gov/nchs/products/pubd/hestats/asthma.htm

Centers for Disease Control and Prevention, Air Pollution and Respiratory Health Branch. Asthma Data from the Behavioral Risk Factor Survey System. 2000.

Centers for Disease Control and Prevention. Self-reported asthma prevalence among adults—united states, 2000. MMWR Morb Mortal Wkly Rep 2001 50(32);682-6.

Centor RM, Yarbrough B, Wood JP. Inability to predict relapse in acute asthma.N Engl J Med. 1984;310(9):577-80.

Chan-Yeung M, Chang JH, Manfreda J, Ferguson A, Becker A. Changes in peak flow, symptom score, and the use of medications during acute exacerbations of asthma. Am J Respir Crit Care Med 1996;154:889-93

Chapman KR, Verbeek PR, White JG, Rebuck AS. Effect of a short course

of prednisone in the prevention of early relapse after the emergency room treatment of acute asthma. N Engl J Med. 1991;324(12):788-94.

Cross D, Nelson HS. The role of the peak flow meter in the diagnosis and management of asthma. J Allergy Clin Immunol 1991;87:120-8.

Dales RE, Schweitzer I, Kerr P, Gougeon L, Rivington R, Draper J. Risk factors for recurrent emergency department visits for asthma.Thorax. 1995;50(5):520-4.

Ducharme FM, Kramer MS. Relapse following emergency treatment for acute asthma: can it be predicted or prevented? J Clin Epidemiol. 1993;46(12):1395-402.

Emerman CL, Cydulka RK. Behavioral and environmental factors associated with acute exacerbation of asthma. Ann Allergy Asthma Immunol. 1998 ;81(3):239-42.

Emerman CL, Cydulka RK. Factors associated with relapse after emergency department treatment for acute asthma. Ann Emerg Med. 1995 Jul;26(1): 6-11.

Emerman CL, Woodruff PG, Cydulka RK, Gibbs MA, Pollack CV Jr, Camargo CA Jr. Prospective multicenter study of relapse following treatment for acute asthma among adults presenting to the emergency department. MARC investigators. Multicenter Asthma Research Collaboration.Chest. 1999;115(4):919-27.

Emerman CL. Relapse following treatment of acute asthma in the emergency department. J Asthma. 2000;37(8):701-8.

Fischl MA, Pitchenik A, Gardner LB. An index predicting relapse and need for hospitalization in patients with acute bronchial asthma. N Engl J Med 1981;305(14):783-9

Ford JG, Meyer IH, Sternfels P, Findley SE, McLean DE, Fagan JK, Richardson L. Patterns and predictors of asthma-related emergency department use in Harlem. Chest. 2001 Oct; 120(4): 1129-35.

Kelsen SG, Kelsen DP, Fleeger BF, Jones RC, Rodman T.Emergency room assessment and treatment of patients with acute asthma. Adequacy of the conventional approach. Am J Med 1978;64(4):622-8

Klaustermeyer WB, Kurohara M, Guerra GA. Predictive value of monitoring expiratory peak flow rates in hospitalized adult asthma patients. Ann Allergy. 1990;64(3):281-4.

Lang, DM, Polansky, M Patterns of asthma mortality in Philadelphia from 1969 to 1991. *N Engl J Med* 1994; 331,1542-1546

Li D, German D, Lulla S, Thomas RG, Wilson SR. Prospective study of hospitalization for asthma. A preliminary risk factor model. Am J Respir Crit Care Med. 1995;151(3 Pt 1):647-55.

Luksza AR. A new look at adult asthma. 1982;76(1):11-4.

Lyon-Callo S, Reeves MJ, Wahl R, Hogan JG. Epidemilogy of Asthma Facto Sheet. Lansing: Michigan Dept. of Community Health, Bureau of Epidemiology, January, 2000.

MaCarren M, McDermott MF, Zalenski RJ, Jovanovic B, Marder D, Murphy DG, Kampe LM, Misiewicz VM and Rydman RJ. Prediction of relapse within eight weeks after an acute asthma exacerbation in adults. J Clin Epidemiol 1998; 51(2):107-118.

Mannino DM, Homa DM, Akinbami LJ, Moorman JE, Gwynn C, Redd SC. Surveillance for asthma--United States, 1980-1999. MMWR Surveill Summ. 2002 29;51(1):1-13.

Mannino DM, Homa DM, Pertowski CA, Ashizawa A, Nixon LL, Johnson CA, Ball LB, Jack E, Kang DS. Surveillance for asthma--United States, 1960-1995. MMWR CDC Surveill Summ. 1998 47(1):1-27.

Marder, D, Targonski, P, Orris, P, et al Effect of racial and socioeconomic factors on asthma mortality in Chicago. *Chest* 1992; 101,426S-429S

Martin R, Elenbaas R, Pingleton S failure of peak expiratory flow rate to predict hospital admission in acute asthma. Ann Emerg Med 1982:11; 466-8.

McCarren M, McDermott MF, Zalenski RJ, Jovanovic B, Marder D, Murphy DG, Kampe LM, Misiewicz VM, Rydman RJ. Prediction of relapse within eight weeks after an acute asthma exacerbation in adults. J Clin Epidemiol. 1998 ;51(2):107-18.

Millqvist E, Bende M, Lowhagen O. Sensory hyperreactivity--a possible mechanism underlying cough and asthma-like symptoms. Allergy 1998;53(12):1208-12.

MMWR: Asthma-United States, 1982-1992. MMWR Morb Mortal Wkly Rep 1995; 43:952-6.

MMWR: Forecasted state-specific estimates of self-reported asthma

prevalence--United States, 1998. MMWR Morb Mortal Wkly Rep. 1998;47(47):1022-5.

MMWR: Mortality and Mortality Weekly Report; 2003:52(17); 381-4.

National Center for Health Statistics. "new Asthma estimates: tracking Prevalence, Health care, and Mortality." Electronic fact sheet 10/15/2001. Hyattsville, Maryland: Public Health Service.

National heart, Lung and Blood Institute. Data Fact Sheet: Asthma Statistics. Bethesda, MD: National Institutes of Health, Public Health Service, January, 1999.

National Heart, Lung, and Blood Institute. Global initiative for asthma: global strategy for asthma management and prevention NHLBI/WHO workshop report, Bethesda, MD: National Institutes of Health, 1995, 50:520-524.

National Institutes of Health. Guidelines for the diagnosis and management of asthma. Bethesda, Maryland: U.S. Department of Health and Human Services, National Institutes of Health, 1997; DHHS publication no. (NIH) 97-4051.

Newcomb RW, Akhter J. Outcomes of emergency room visits for asthma. I. Patient determinants. J Allergy Clin Immunol 1986;77(2):309-15.

Nowak RM, Pensler MI, Sarkar DD, Anderson JA, Kvale PA, Ortiz AE, Tomlanovich MC. Comparison of peak expiratory flow and FEV1 admission criteria for acute bronchial asthma. Ann Emerg Med. 1982;11(2):64-9.

Reeves MJ. Asthma Surveillance in Michigan: Hospitalizations and Deaths Due to Asthma. Presentation at Michigan Asthma strategic Planning Initiative Task Force meeting, Feb. 2, 2000.

Rose CC, Murphy JG, Schwartz JS. Performance of an index predicting the response of patients with acute bronchial asthma to intensive emergency department treatment. N Engl J Med. 1984;310(9):573-7.

Rothman KJ. Analysis of Crude data. In: Modern Epidemiology . Boston: Little, Brown and Company; 1986:153-176.

Weiss KB, Gerogen PJ, Hodgson TA. An economic evaluation of asthma in the United States. N Engl J Med 1992;326:862-6.

Weiss KB, Grant EN, Li T. The effects of asthma experience and social demographic characteristics on responses to the Chicago Community

Asthma Survey-32. Chicago Asthma Surveillance Initiative Project Team. Chest. 1999;116(4 Suppl 1):183S-189S

Weiss, KB, Wagener, DK Changing patterns of U.S. asthma mortality: identifying target populations at high risk *JAMA* 1990; 264(13),1683-8.

Worthington JR, Ahuja J.The value of pulmonary function tests in the management of acute asthma.CMAJ. 1989;140(2):153-6.