

Factors Associated with Emergency Department Visits in Asthma Exacerbation

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Objectives: Despite quality improvement initiatives to prevent asthma-related emergency department (ED) visits, rates have not declined. We sought to determine factors associated with ED visits in an underserved population.

Methods: We performed a case-control analysis of asthma patients at three ambulatory care centers serving low-income populations. Cases consisted of asthmatic patients aged 18 to 45 years with ≥ 1 ED visit for an asthma exacerbation between August 1, 2008 and July 31, 2010. Controls were patients with asthma aged 18 to 45 years with ≥ 1 outpatient visit during the same period but with no asthma-related ED visit. Data were collected by chart review and included demographics, past referral for asthma education or to a pulmonologist, recent tobacco use, influenza vaccination, and asthma medication prescriptions in the year before the index visit.

Results: Among 244 cases and 475 controls, there were no significant differences in age, sex, or ethnicity. Cases were more likely than controls to have ever been referred for asthma education (odds ratio [OR] 4.09, 95% confidence interval [CI] 2.57–6.50) or to a pulmonologist (OR 2.31, 95% CI 1.15–4.66). In the year before the index visit, cases were more likely than controls to receive other medications in addition to inhaled corticosteroids (ICS; OR 1.74, 95% CI 1.14–2.66) but less likely to receive influenza vaccination (OR 0.49, 95% CI 0.34–0.71), a short-acting β -agonist (OR 0.43, 95% CI 0.24–0.78), or ICS alone (OR 0.53, 95% CI 0.34–0.84).

Conclusions: Markers of severe disease were associated with ED visits, as well as a lack of an influenza vaccination and failure to prescribe either ICS or short-acting β -agonists.

Key Words: asthma exacerbation, emergency visits, influenza vaccination, inhaled corticosteroids, short-acting β -antagonists

Asthma is the most common chronic respiratory condition in the developed world, affecting up to 10% of adults and 30% of children.^{1–3} Outpatient therapy with potent inhaled corticosteroids (ICS), long-acting β -agonists (LABA), and leukotriene antagonists (LT4A) has proven effectiveness in limiting asthma symptoms and preventing exacerbations requiring systemic steroids.⁴ As a result, despite an increasing incidence of asthma in the United States, between 1980 and 2005 asthma-related hospitalizations fell from 18/10,000 to <15/10,000.⁴ For the past decade, however, emergency department (ED) visits for asthma have remained frustratingly stable.³ The reasons for this are unknown. Because of the effectiveness of ICS, quality improvement initiatives have focused on outpatient prescribing of these medications; however, other practices may be more important in reducing ED visits.

Key Points

- Asthma remains a common cause of emergency department visits.
- Among an underserved urban population of asthmatics, ethnicity was not associated with asthma-related emergency department visits.
- Markers of severe asthma disease, including needing asthma medications in addition to inhaled corticosteroids and a history of visiting an asthma educator or pulmonologist, predicted emergency asthma visits.
- Failure to administer influenza vaccinations predicted emergency asthma visits.
- Inhaled corticosteroids and short-acting β -agonist prescriptions alone are associated with fewer emergency asthma visits.

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Factors that predict asthma-related ED visits and hospitalizations are nonwhite race, low socioeconomic status, and greater asthma severity.^{5–7} In addition, for adults with asthma who do not have insurance, the cost of physician visits and medications poses a barrier to achieving control and may lead to ED visits.^{8,9} Although the association between asthma severity and ED visits makes sense, the reason for the association with race and socioeconomic status is less clear. The contributions of asthma education, medication prescribing, and influenza vaccinations are unknown as well and are likely to affect ED visits with asthma exacerbation. To better inform initiatives to reduce ED visits, we sought to assess factors associated with asthma-related ED visits in a population of underserved individuals who have access to primary care.

Methods

Study Design and Setting

We performed a case-control study at three academic community health centers that cater to underserved, low income populations in Springfield, Massachusetts. Using our health system's billing database, we identified all patients aged 18 to 45 years with *International Classification of Diseases, Ninth Revision* asthma codes 493.00 to 493.99, who had at least one clinic visit between August 1, 2008 and July 31, 2010. Patients with chronic obstructive pulmonary disease, cystic fibrosis, or other obstructive lung diseases were excluded. Cases were defined as patients who had made at least one visit to the ED for an asthma exacerbation during the study period. The control group consisted of asthma patients who were seen in the clinic but did not visit the ED for asthma. Control patients were chosen by a random number generator in a 2:1 ratio to cases. The study was approved by the institutional review board at Baystate Medical Center.

Sample Size Estimation

We wished to have approximately 80% power to detect a twofold increase in the odds of case status due to exposure for a two-sided test of significance at a critical level of 5%. Although asthma is common, most asthmatics do not visit the ED as evidenced by 2 million ED visits for asthma among 25.9 million asthmatics nationwide in 2010.¹⁰ Given the limited number of eligible cases and the larger number of potential controls, we chose a 2:1 sampling ratio (twice as many controls as cases) to achieve the desired power. Conservatively assuming the prevalence of any exposure of interest to be 10%, the estimated number of subjects needed was 237 case charts and 475 control charts.

Data Collection

Data were collected by chart review, and for each patient we collected age, sex, and ethnicity demographic data. We determined whether patients had a documented referral for asthma education or a visit to a pulmonologist's office at any

time before the index visit (ie, date of ED visit for a case patient or date of clinic visit for a control patient randomly chosen within the 2-year period of interest). For case patients with multiple ED visits during this time, we used a random number generator to determine the index visit. Our decision to use a random number generator was to analyze a more representative sample of patients for the study period and to limit time bias. In addition, we were interested not only in first ED visits but also in subsequent visits. For the year before the index visit we recorded all prescriptions for asthma medications, administration of influenza vaccine, and tobacco usage. All-cause clinic and ED visits in the year before the index visit were recorded as well. For cases, we recorded data regarding the primary care received following the asthma-related ED visit. We recorded the time to the first follow-up visit, whether asthma was addressed at that visit, medication changes that were implemented, and any referrals that were made.

Statistical Analysis

Descriptive statistics (means and standard deviations) were generated for continuous measures and frequency distributions for categorical variables. Cases and controls were compared on univariable analysis using the χ^2 statistic for discrete factors and the Student *t* test for continuous factors. The significance criterion of 0.2 was used to include variables in the multivariable analysis. Several variables including use of LABA, chromones, and omalizumab could not be tested because too few patients used them.

Variables that were significant on univariable analysis were tested for their association with case status (risk of ED visit for asthma exacerbation) using multiple logistic regression. A backwards stepwise procedure was used to select variables for inclusion in the model. Model fit was assessed using the Hosmer-Lemeshow statistic. Area under the curve analysis was used to assess prediction validity (classification accuracy) of the logistic model.¹¹

Results

Our final dataset included 244 cases and 475 controls. Patient characteristics appear in Table 1. Cases and controls did not differ significantly by age, ethnicity, or sex. Almost all patients had been prescribed asthma medication in the past year; cases were less likely to have received short-acting β -agonists (SABA) and ICS as lone controller medications and were more likely to have received ICS with additional controller medications, perhaps indicating that cases had more severe disease. Similarly, in the year before the index date, cases had more ED visits (but not more clinic visits) and were more likely to have seen a pulmonary specialist or an asthma educator and were less likely to smoke. Despite appearing to be at higher risk, cases were less likely to have received an influenza vaccine. In the multivariable model the same factors were associated with an ED visit for asthma (Table 2).

Table 1. Baseline description of cases and controls

	Control (n = 475)	Cases (n = 244)	P
Male (%)	119 (25.1)	67 (27.5)	0.485
Age, y	32.0	33.2	0.0719
Ethnicity (%)			0.308
Hispanic	331 (69.7)	167 (68.4)	
Black	75 (15.8)	110 (18.4)	
White	57 (12.0)	31 (12.7)	
Other	1 (0.2)	0	
Tobacco use (%)*	188 (41.4)	83 (34.9)	0.101
Influenza vaccine (%)*	204 (43.5)	71 (29.1)	<0.001
Specialist visit ever (%)	18 (3.8)	38 (15.6)	<0.001
Asthma education ever (%)	46 (9.7)	76 (31.1)	<0.001
Mean all-cause ED visits*	0.74	1.32	0.005
Mean all-cause clinic visits	4.56	5.07	0.12
Asthma prescriptions (%)*	454 (95.5)	209 (100)	<0.001
SABA (%)†	445 (93.7)	207 (84.8)	<0.001
ICS (%)‡	203 (42.7)	62 (25.4)	<0.001
ICS + LABA (%)§	58 (12.2)	60 (24.6)	<0.001
LT4A (%)	47 (9.9)	57 (23.4)	<0.001
Anticholinergic (%)¶	6 (1.3)	22 (9)	<0.001

ED, emergency department; SABA, short-acting β -agonists; ICS, inhaled corticosteroids; LABA, long-acting β -agonists; LT4A, leukotriene antagonists.

* Occurring in 1 year before index visit.

†SABA: albuterol, levalbuterol, including nebulized formulations.

‡ICS: budesonide, fluticasone, mometasone.

§LABA: salmeterol, formoterol.

||LT4A: montelukast, zafirlukast.

¶Anticholinergics: tiotropium, ipratropium.

Following an ED visit for asthma, the median time to a follow-up visit with a primary care provider was 75 days. At that visit, 63% of patients had their asthma addressed. There were medication changes and/or new prescriptions in 23% of cases. There was documented asthma education or a referral to an asthma educator in 30% of cases and 14% were referred to a pulmonologist.

Discussion

Asthma is a common cause of ED visits and a frequent target of quality improvement programs. The latter emphasize the prescription of controller medications, primarily ICS, to prevent and manage exacerbations¹²; however, despite the existence of effective therapy, ED visits for asthma have remained stubbornly high for the past decade. Minority patients have particularly high rates of asthma, as well as more limited access to primary care. In this case-control study of three urban health centers where all patients had access to primary care, we found that ethnicity was not associated with emergency visits for asthma. In contrast, markers of severe asthma, as indicated by previous referrals to a pulmonologist and asthma educators, more frequent all-cause visits to the ED and treatment with second-line therapies were

strongly associated with asthma-related ED visits, whereas SABA and/or ICS as a lone controller and an influenza vaccination were associated with fewer emergency visits.

Previous studies have found that both blacks and Hispanics are more likely than whites to visit EDs for asthma.^{5–7} In a prospective study of 64 EDs in the United States and Canada, Boudreaux et al reported that blacks and Hispanics report a greater number of ED visits but also are less wealthy, less likely to have private insurance, and less likely to have a primary care provider compared with their white counterparts.⁶ Eisner et al revealed that nonwhite race increased the risk of asthma hospitalization when adjusted for household income and other covariates in a population with access to health care.⁵ Our study population is more similar to the population studied by Eisner et al in that all of the subjects studied had access to primary care. Unlike Eisner et al, we collected retrospective data and were unable to define the incomes of study participants; nevertheless, the majority of subjects in our study were of similar low socioeconomic status owing to the fact that our ambulatory care centers cater primarily to such patients. The difference observed in the association of ethnicity on ED visits may relate to differing study designs and other unappreciated confounders between our study and the Eisner study. Smith and colleagues examined a retrospective cohort of Medicaid population in Arizona and found no effect of ethnicity on the odds of visiting the hospital with an asthma exacerbation.¹³ More striking population-based data by Hasegawa and colleagues report that among 86,224 patients with 131,907 asthma-related ED visits, black race and Hispanic ethnicity, when adjusted, were significant predictors of multiple ED visits.¹⁴ The relation between ethnicity and asthma-related ED visits remains unclear; nevertheless it is important to identify and assist adult asthmatics

Table 2. Multivariable model of factors associated with ED visits for asthma exacerbations

Independent variables	OR (95% CI)	P
Mean all-cause ED visits*	1.14 (1.04–1.25)	0.007
Pulmonary specialist visit ever	2.31 (1.15–4.66)	0.019
Asthma education ever	4.08 (2.57–6.50)	<0.001
Tobacco use*	0.73 (0.51–1.05)	0.091
Influenza vaccine*	0.49 (0.34–0.71)	<0.001
SABA	0.43 (0.24–0.78)	0.006
Drug classification compared with SABA alone or no asthma medication		
ICS only	0.53 (0.33–0.84)	0.007
ICS + other asthma medication†	1.74 (1.14–2.66)	0.010

CI, confidence interval; ED, emergency department; ICS, inhaled corticosteroids; LABA, long-acting β -agonists; LT4A, leukotriene antagonists; OR, odds ratio; SABA, short-acting β -agonists.

*Occurring in 1 year before index.

†Other asthma medications include LABA, anticholinergics, and LT4A.

who are in high-risk groups to improve population health and reduce asthma-related healthcare costs.

Our results have some important implications for quality improvement programs. Approximately one-fourth of patients in our study were already taking ICS plus another asthma medication, yet this combination was positively associated with an ED visit when compared with SABA alone or no asthma medication. Taylor et al reported that the intensity of treatment required to achieve good asthma control is a clinically useful concept of asthma severity.¹⁵ Cases also had more all-cause ED visits and were more likely to have been to an asthma educator or pulmonologist. For these case patients, it seems that markers of more severe asthma predict ED visits, and there would be little room for improvement by stricter adherence to prescribing guidelines. Other strategies such as avoidance of triggers or improved access to physicians after hours may be necessary. Lastly, asthmatics who still visit the ED while taking ICS plus additional controller medications may be corticosteroid insensitive and their airway inflammation is mediated by neutrophils.¹⁶ Efforts to better characterize the asthma phenotype in these patients may facilitate reductions in ED visits and better-quality asthma care.

ICS have been shown to reduce asthma exacerbations requiring prednisone and are the most efficacious medication for long-term management.^{17–19} ICS also have been shown to reduce subsequent ED visits when initiated following ED treatment for asthma.²⁰ Consequently, ICS are the mainstay of therapy and have been the target of quality improvement initiatives.²¹ In a prospective cohort study involving 64 North American EDs, Hasegawa et al reported that among asthmatics who visited the ED, 70% exhausted their supply of ICS before the onset of their symptoms.²² Our study extends these findings to a general primary care population. Approximately half of the cases in our study did not have an ICS and our results suggest that ICS, when prescribed alone, were associated with fewer ED visits compared with either SABA alone or to no asthma medications. We interpret these findings to relate to a group of asthmatics with less severe disease adequately controlled with ICS alone.

Approximately 15% of subjects received LT4A for asthma care. LT4A have proven comparable efficacy to ICS as a first-line controller medication.²³ LT4A prescriptions were not associated with fewer ED visits, however. We performed a sensitivity analysis comparing LT4A versus ICS and LT4A versus ICS plus additional controller medications. The numbers in the subgroups were small and hypothesis testing for significance was not appropriate. In a study by Price et al, patients treated with ICS and LT4A had similar rates of asthma exacerbations but authors do not comment on the effects on ED visits.

The use of LABA was surprisingly low in our case-control analysis, 16%, with most LABA prescribed as an ICS + LABA combination; however, upon a literature review of 3.6 million asthma cases from the IMS LifeLine Database, LABA-containing prescriptions had an incidence of 6.33%.²⁴

An inactivated trivalent influenza vaccine is a safe preventive measure against influenza infection.²⁵ In addition, there is no reported increased incidence of asthma exacerbations with its use.^{26,27} Influenza infection frequently is associated with hospitalizations for asthma.²⁸ Certainly a reduction in influenza infection may translate into a lower incidence of ED visits related to asthma. Despite guidelines from the Centers for Disease Control and Prevention that recommend vaccination for asthma patients, <30% of our cases had received the influenza vaccine in the previous year and that lack of vaccination was associated with an ED visit.²⁹

Timely follow-up is essential to ensure an adequate transition of care and limit adverse outcomes.³⁰ Referral for a follow-up appointment following ED and hospital discharge is a quality measure in asthma management.¹² We found that following an ED visit, the time to primary care follow-up often was prolonged, with a median follow-up time of >2 months; this was despite the fact that all patients had access to primary care physicians.

Finally, tobacco use is widely known to worsen asthma symptoms.^{31,32} In our study, 34% of patients seen in the ED were still smoking, although paradoxically, tobacco smoking was inversely associated with ED visits. This finding likely represents physicians' success in getting patients with more severe asthma to quit smoking, so that mostly patients with mild asthma continued to smoke.

Our study has several limitations. First, as a result of the case-control design we were not able to establish rates of ED visits or absolute risks attributable to any of the interventions. Second, the observational design makes it subject to confounding; however, benefits of most interventions were similar to those seen in randomized trials. Third, race and ethnicity were self-reported and the patients were presumed to be of lower socioeconomic status because they received primary care at our center, which predominantly treats lower-income patients. We made no effort to better define these demographic terms. Fourth, we report prescriptions in the year before the index visit, but we are unable to determine medication adherence because of the retrospective study design. Medication nonadherence is well recognized in asthma, with reported rates as high as 70%.³³ Fifth, although most patients from our clinics seek emergency care at our institution, we cannot ascertain whether some subjects sought acute asthma care at the other EDs in our area. Finally we observed associations but could not establish cause and effect. Although it makes sense that an influenza vaccination and ICS prescriptions from primary care providers could prevent asthma-related ED visits, this study can only generate hypotheses.

In conclusion, asthma remains a common cause of emergency visits in underserved populations, despite clear treatment guidelines and effective therapies. These visits appear to represent a heterogeneous group of patients, some of whom receive appropriate treatment but have severe disease and others who have milder disease that has not been cared for appropriately.

Emphasizing SABA, ICS, and influenza vaccinations in the latter group may be effective for reducing ED visits among underserved patients. The effect of ethnicity on asthma-related ED visits remains unclear.

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