
Multicenter study of cigarette smoking among patients presenting to the emergency department with acute asthma

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Background: Many studies have focused on smoking and chronic asthma severity. However, research on the relationship between smoking and acute asthma severity in an acute care setting is sparse.

Objectives: To determine the smoking prevalence among emergency department (ED) patients with acute asthma and to investigate the relationships between smoking and acute asthma severity.

Methods: A 63-site medical record review study of ED patients, ages 14 to 54 years, with a principal diagnosis of acute asthma was performed. Patients with chronic obstructive pulmonary disease were excluded. Measurements for acute asthma severity included sociodemographic factors, asthma medical history, ED presentation, clinical course, medications administered, and return visit within 48 hours.

Results: A total of 4,052 patient medical records were reviewed. A total of 1,332 patients (33%; 95% confidence interval, 31%–34%) were documented as smokers. No statistically significant differences were found between smokers and nonsmokers in vital signs, oxygen saturation, peak expiratory flow, and administration of asthma medications. By contrast, smokers were more likely than nonsmokers to receive antibiotics in the ED (12% vs 9%, $P < .001$) or at discharge (23% vs 14%, $P < .001$). A multivariate analysis confirmed that smoking status was independently associated with antibiotic administration (odds ratio, 1.6; 95% confidence interval, 1.3–1.8).

Conclusions: One-third of ED patients with acute asthma smoked cigarettes. Smokers and nonsmokers did not differ in their acute asthma severity. Asthmatic smokers, however, were more likely to receive antibiotics, even when adjusting for other possible confounders.

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INTRODUCTION

Cigarette smoking has profound deleterious effects on the respiratory system. It initiates microscopic changes at a cellular level with the apoptosis of alveolar cells and endothelial cell malfunction,^{1,2} creating an environment that leads to macroscopic structural and functional destruction. Over time,

these cumulative insults cause a progressive deterioration in pulmonary function.^{3–6}

The deterioration of pulmonary function is worse in patients with asthma who smoke. Longitudinal studies in patients with asthma who smoke have demonstrated steep declines in pulmonary function.^{3,4} Over the years, the rate of decline in pulmonary function, as measured by forced expiratory volume in 1 second (FEV₁), is accelerated by smoking in patients with asthma.⁶ Cigarette smoking also worsens chronic asthma symptoms, such as cough, wheezing, and shortness of breath,^{7–9} and increases emergency department (ED) visits and hospitalizations in patients with chronic asthma.¹⁰

Considering the effects of smoking on the respiratory system, one would expect that patients with asthma presenting to an ED for an acute asthma exacerbation would refrain from smoking cigarettes. However, approximately 35% of adult patients with asthma presenting to EDs in the United States smoke based on data collected from 1996 to 1998.¹¹ With the additive effects of smoking and asthma on pulmonary function, patients with asthma who smoke may have more severe acute asthma severity than those who do not smoke, as evidenced by lower peak expiratory flow (PEF), poor response to treatment, and more aggressive management. How-

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ever, few studies have investigated the relationship between smoking and these variables. With more than 1.7 million ED visits for asthma annually,¹² this is an important question with implications for patients and emergency care professionals. The objectives of this study were to determine the current prevalence of smoking in patients presenting to the ED with an acute asthma exacerbation and to examine whether cigarette smoking was associated with more severe acute asthma severity as measured by vital signs, PEF, aggressive management with respect to medications, and ED disposition.

METHODS

The National Emergency Department Safety Study was a patient safety study based in US EDs. Details of the study's methods have been published previously.¹³ Our analysis used data from the study's asthma medical record review component.

A total of 63 EDs participated, with most sites ($n = 48$) being academic EDs (ie, affiliated with an emergency medicine residency program). Patients were included in this study if they were between the ages of 14 and 54 years and had a principal ED or hospital discharge diagnosis of asthma (*International Classification of Diseases, Ninth Revision, Clinical Modification* codes 493.xx). Each site reviewed medical records during a 12-month period from January 1, 2003, through December 31, 2006. Patients with a history of chronic obstructive pulmonary disease (COPD), no antecedent history of asthma before the index visit, visits not solely prompted by asthma exacerbation, or repeat visits by the same patient for asthma during the study period were excluded. Sites reviewed 70 medical records randomly selected by the project director at the Emergency Medicine Network¹⁴ Coordinating Center. If fewer than 70 medical records were available in the 12-month period ($n = 10$ sites), abstractors reviewed all eligible records. The institutional review board at all participating hospitals approved the study.

The medical record abstraction form documented basic demographic information, including age, sex, race, asthma history, current asthma medications, and smoking status. Patients were considered smokers if they had a history of active smoking of cigarettes anytime within 12 months before ED arrival. Patients were considered nonsmokers if documentation existed that they had never smoked, if they smoked in the past but quit greater than 1 year ago, or if there was no information in the medical record about smoking. This definition helped to ensure that patients with a recent history of smoking were included as smokers because patients minimize their smoking or stop smoking before their ED visit because of illness. It also made the definition consistent with the 12-month timeline used for the other variables abstracted.

Data on duration of symptoms and initial vital signs were obtained from the medical records. Initial, second, and final PEFs, if documented, were recorded in liters per minute and expressed as an absolute value; no predicted values were presented because of infrequent recording of the patient's

height. Any medications administered in the ED, disposition, and return visit within 48 hours were recorded.

Summary statistical analyses are presented as proportions with 95% confidence intervals (CIs) or medians with interquartile ranges (IQRs). The associations between smoking and categorical variables were examined using χ^2 or Fisher exact tests, as appropriate. The associations between smoking and continuous variables were examined using Wilcoxon rank sum tests after assessing data for normality. Multivariate logistic regression modeling was performed to evaluate the association between smoking and antibiotic use in the ED or at discharge. Age and sex were included throughout the model building process because of their historical associations with smoking. Variables associated with smoking or antibiotic use at $P < .10$ in univariate analyses were considered eligible for inclusion in the multivariate model.¹⁵ Models with and without potential causal intermediates were presented separately to see how much of the effect of smoking was mediated through these variables.¹⁶ To account for the effects of clustering of patients within EDs, the multivariate models were fit by using generalized estimating equations.¹⁷ To maximize the use of available information, we dummy coded variables with substantial missing data (race/ethnicity and initial PEF) using the missing indicator method.¹⁸ Odds ratios (ORs) are presented with 95% CIs. All analyses were performed using Stata statistical software version 9.0 (StataCorp, College Station, Texas). All P values are 2-sided, with $P < .05$ considered statistically significant.

Two sensitivity analyses were performed to test the robustness of the findings on smoking and antibiotic use. First, we excluded patients younger than 18 years (7% of the study population) and repeated the analyses. The results were similar and are not reported. Second, although COPD cases were excluded, we further restricted the analysis to patients younger than 40 years to eliminate potential confounding by undiagnosed COPD.

RESULTS

A total of 4,052 medical records of patients with acute asthma were reviewed, and 33% (95% CI, 31%–34%) were found to smoke cigarettes. The median age of the smokers was 34 years (IQR, 24–43 years); 64% were women, and 47% were black. Compared with nonsmokers, smokers were more likely to be older and male (Table 1). No statistically significant differences were found in race/ethnicity and medical history pertaining to asthma between both groups.

Nonsmokers were more likely to be prescribed asthma medications at the time of their ED visit, including inhaled short-acting β -agonists (SABAs), inhaled long-acting β -agonists (LABAs), inhaled corticosteroids, and oral corticosteroids. However, despite differences in current asthma medication use, clinical parameters on ED presentation, such as initial respiratory rate, oxygen saturation, and PEF, were all similar (Table 2). Smokers reported more recent upper respiratory tract infection symptoms (34% vs 31%, $P = .02$) than nonsmokers.

Table 1. Demographic and Baseline Clinical Characteristics of Patients Presenting to the Emergency Department With Acute Asthma^a

Characteristics	Smokers (n = 1,332)	Nonsmokers (n = 2,720)	P value
Demographic factor			
Age, y	35 (25–43)	33 (23–43)	<.001
Male sex	40	34	<.001
Race/ethnicity ^b			.88
White	33	32	
Black	47	47	
Hispanic	17	18	
Other	3	3	
English as primary language	98	97	.04
Currently pregnant ^c	2	4	.01
Chronic asthma factor			
Ever hospitalized for asthma	25	25	.96
Admitted to ED for asthma in past year	9	9	.92
ED visit for asthma in past year	24	22	.35
Ever intubated or received ventilatory support for asthma	9	9	.89
Current asthma medication			
Inhaled SABAs	77	82	.001
Inhaled LABAs	15	21	<.001
Inhaled corticosteroids	23	30	<.001
Oral corticosteroids	8	12	.001
Leukotriene modifiers	7	15	<.001
Inhaled anticholinergics	7	6	.22
Methylxanthine	2	2	.25

Abbreviations: ED, emergency department; LABAs, long-acting β -agonists; SABAs, short-acting β -agonists.

^a Data are presented as percentage or median (interquartile range) unless otherwise specified.

^b Available for 2,629 patients.

^c Among 2,593 women.

The majority of ED asthma management did not differ between the groups (Table 2). Administration of inhaled β -agonists, inhaled anticholinergics, and systemic corticosteroids were similar between smokers and nonsmokers. No statistically significant difference was seen in more intensive asthma treatment modalities, such as magnesium, epinephrine, and intubation with mechanical ventilation. Nonsmokers were more likely to receive heliox (1% vs 0.3%, $P = .03$).

Smokers were more likely than nonsmokers to receive antibiotics in the ED (12% vs 9%, $P < .001$), as well as at discharge (23% vs 14%, $P < .001$) (Tables 2 and 3). The increased risk of antibiotic use among smokers persisted in patients younger than 40 years (OR, 1.5; 95% CI, 1.2–1.9), for whom confounding by COPD would be unlikely. The OR for antibiotic use comparing smokers with nonsmokers was 1.6 (95% CI, 1.3–1.8) when adjusted for age, sex, ethnicity, and primary language (Table 4) and decreased to 1.4 (95% CI, 1.2–1.7), yet remained statistically significant, when upper respiratory tract infection symptoms, duration of symptoms, transport to ED by ambulance, initial respiratory rate, and initial PEF were also included with the aforementioned covariates.

ED disposition and discharge medications were equivalent among both groups, with the exception that smokers were more likely to be discharged with an antibiotic prescription (23% vs 14%, $P < .001$). No difference was found in return visits within 48 hours.

DISCUSSION

The prevalence of smoking among asthmatic patients who present to EDs in our sample was 33% (95% CI, 31%–34%), which is similar to the prevalence of 35% found by Silverman et al¹¹ in 1996 to 1998. Although there has been a steady decrease in the rate of smoking in the US adult population during the past 10 years to 21%,¹⁹ there seems to be no change in prevalence of smoking among individuals with asthma who present to EDs. This persistently high prevalence of smoking among patients with asthma is surprising considering the well-documented patterns of reduced lung function in adults by cigarette smoking.^{3–6} A more concerted effort of smoking cessation should be directed at this population because smoking cessation can decrease pulmonary function decline in patients with asthma.²⁰

Examination of the smoking prevalence among all patients presenting to an ED varies widely from 21% to 41%.^{21–23} The smoking prevalence of 33% in our patients with asthma falls into this range. However, the smoking prevalence in our sample is higher than that among asthmatic individuals in the general population, which is estimated to be 10%.²⁴ The trend that ED patients smoke at higher rates than that of the general population not only is observed in asthma but also has been reported across other emergency disease presentations.²⁵

Another possibility for the high prevalence of smoking in ED asthma patients may be related to economics. Economi-

Table 2. Emergency Department Presentation and Management Among Patients With Acute Asthma by Smoking Status^a

Variable	Smokers (n = 1,332)	Nonsmokers (n = 2,720)	P value
Pre-ED condition			
Recent upper respiratory tract infection	34	31	.02
Evaluation for asthma in last 3 days	7	8	.14
Duration of symptoms			.02
<24 hours	32	37	
1–3 days	44	40	
4–7 days	14	13	
>7 days	10	10	
Transported to ED by ambulance	23	19	.008
ED presentation			
Initial respiratory rate, /min	20 (18–24)	20 (19–24)	.08
Initial oxygen saturation, % ^b	97 (95–99)	98 (95–99)	.10
Initial oxygen saturation on room air, % ^c	97 (95–99)	97 (95–99)	.17
Initial PEF, L/min ^d	240 (170–300)	240 (170–315)	.27
Second PEF, L/min ^e	290 (210–350)	300 (230–350)	.64
Percent change from initial to second PEF, % ^e	25 (6–50)	27 (10–50)	.19
Final PEF, L/min ^f	330 (250–400)	330 (260–400)	.34
ED management			
Received inhaled β -agonists in ED	92	91	.31
No. of inhaled β -agonists in first hour	1 (1–2)	1 (1–2)	.15
No. of inhaled β -agonists during ED stay	2 (1–3)	2 (1–3)	.19
Received systemic corticosteroids in ED	69	69	.85
Received inhaled anticholinergics in ED	67	65	.10
Received antibiotics in ED	12	9	<.001
Received methylxanthine in ED	0.2	0.4	.36
Other asthma treatments in ED			
Received intravenous magnesium in ED	5	5	.98
Heliox	0.3	1	.03
Intubation or mechanical ventilation	0.5	0.5	.91
Received subcutaneous or intramuscular epinephrine or terbutaline in ED	2	2	.79

Abbreviations: ED, emergency department; PEF, peak expiratory flow.

^a Data are presented as percentage or median (interquartile range) unless otherwise specified.^b Available for 3,970 patients.^c Available for 3,077 patients.^d Available for 1,877 patients.^e Available for 1,346 patients.^f Available for 866 patients.

cally disadvantaged individuals are most likely to smoke and are disproportionately represented in ED settings.¹¹ Patients with asthma who continue to smoke may also be benefitting from the “healthy smoker” effect.^{8,26} If asthma patients do not feel the short-term ill effects of smoking, either through more severe or more frequent exacerbations, they may continue to smoke despite its long-term deleterious effects on lung function.

Given the high smoking rates in ED patients, the ED may represent an opportune setting to initiate smoking cessation. One of the deterrents to cessation counseling has been an unwillingness of emergency physicians to devote time and resources toward this end. Although emergency physicians inquire about smoking in more than half of their patients, only a small percentage counsel or refer their patients to smoking cessation programs.^{27,28} This is true despite a strong interest in quitting among ED smokers,^{28–30} especially in

patients who perceive their current illness to be smoking related.²⁹ Because smoking and asthma act synergistically to cause a progressive decline in lung function, it is imperative that patients willing to quit be identified early and counseled.

Smokers were less likely to use medications for chronic asthma compared with nonsmokers, a finding that has been observed in other studies.^{7,11} It is unclear what underlies this pattern. Asthmatic patients who smoke may be noncompliant with medications. Another reason may be that patients with asthma who smoke have a blunted perception of airway obstruction,³¹ causing them to underestimate their asthma severity, leading to a decrease in asthma medication use. Finally, smoking asthmatic patients may be prescribed medications at lower rates than nonsmoking patients for some as yet undetermined reason.

Longitudinally, smoking worsens lung function in asthmatic patients.^{3,4,6} Certain asthmatic patients actively exposed

Table 3. Emergency Department Outcomes and Discharge Medications Among Patients With Acute Asthma by Smoking Status^a

Variable	Smokers (n = 1,332)	Nonsmokers (n = 2,720)	P value
ED outcome			
Admission (ward, observation, ICU)	19	18	.54
ED length of stay, hours	3 (2–5)	3 (2–5)	.15
Concomitant infection diagnosis			
Pneumonia	3	3	.81
Sinusitis	1	1	.16
Discharge medication ^b			
Oral corticosteroids	59	61	.30
Inhaled corticosteroids	17	17	.88
LABAs	6	7	.38
Leukotriene modifiers	1	3	.01
Oral antibiotics	23	14	<.001
Follow-up outcome ^b			
Revisit or readmission within 48 hours	2	1	.20

Abbreviations: ED, emergency department; ICU, intensive care unit; LABAs, long-acting β -agonists.

^a Data are presented as percentage or median (interquartile range) unless otherwise specified.

^b Restricted to patients sent home from the ED (n = 3,206).

Table 4. Univariate and Multivariate Associations Between Smoking and Antibiotic Use in the ED or at Discharge

Model	OR (95% CI) ^a
Model 1 (crude)	1.6 (1.4–1.9)
Model 2 (adjusted for age and sex)	1.6 (1.4–1.8)
Model 3 (adjusted for above plus race/ethnicity and primary language)	1.6 (1.3–1.8)
Model 4 (adjusted for above and 5 factors) ^b	1.4 (1.2–1.7)

Abbreviations: CI, confidence interval; ED, emergency department; OR, odds ratio.

^a Generalized estimating equations were used to account for the effects of clustering of patients within EDs.

^b Multivariate model includes age, sex, race/ethnicity, primary language, plus 5 potentially intermediate factors (upper respiratory tract infection, duration of symptoms, transported to ED by ambulance, initial respiratory rate, and initial peak expiratory flow).

to cigarette smoke in laboratory studies experience a worsening of their pulmonary function.^{32,33} Other studies using patient self-report of symptom severity have likewise shown a positive association between smoking and asthma severity.^{7–10,34–36} However, reports on smoking and acute asthma severity have contradicted these trends. We found no difference in acute asthma severity between smokers and nonsmokers as evidenced by similar vital signs, initial PEF, PEF after treatment, medical treatment, or disposition. Similarly, Silverman and colleagues,¹¹ also using an ED sample, found no relationship between smoking and asthma severity. Other studies that used single-point measurements of PEF and FEV₁ observed no relation between smoking and short-term change in PEF or FEV₁.^{11,35,36} The lack of agreement in this literature appears to fall primarily between chronic asthma studies, which find positive associations between smoking and severity, and those that study acute asthma exacerbations, which do not. Asthmatic patients who smoke may have a worse chronic course of asthma than those who do not smoke but

may not objectively have a decline in pulmonary function during a specific point in time or during an acute exacerbation. The paradoxical findings between acute and chronic phases of diseases have also been reported in the context of COPD.³⁷ Future studies designed to disentangle this relationship should examine how smoking affects both the acute exacerbation and the chronic course.

Disposition did not differ between smoking and nonsmoking asthmatic patients, another indicator of no difference in asthma severity between the groups. Weber et al³⁸ demonstrated that smoking was not a risk factor in admission to the hospital for asthma. These findings differ from findings by Shavit and colleagues,¹⁰ who studied 852 asthmatic patients and found that the odds of hospitalization for asthma patients who smoke was 1.8. However, it was not clear if the hospitalization was secondary to asthma or for other illnesses.

Asthmatic patients who smoked were more likely to receive and be discharged with a prescription for antibiotics despite no difference in illness severity between the groups. Increased antibiotic use was independent of age, race, and sex. The sensitivity analysis with younger patients found the same pattern, excluding any potential confounding by COPD, seen in older patients. Patients with asthma who smoked reported more recent upper respiratory tract infection symptoms than nonsmokers before their ED visit, but the association between smoking and antibiotic use remained after adjusting for this pattern in the multivariate analysis. Furthermore, this increased self-reporting of upper respiratory tract infection symptoms should not justify an increased prescription of antibiotics because an overwhelming proportion of upper respiratory tract infections are viral in origin, with antibiotics having no effect on disease severity or length.³⁹ ED physicians often justify their liberal use of antibiotics with the explanation that patient satisfaction with care was dependent on the receipt of antibiotics, but data do not support this contention.⁴⁰

The perception of a productive cough may influence physicians to prescribe antibiotics; Ong et al⁴⁰ showed an OR of 1.7 for prescribing antibiotics based on report of a cough and an OR of 2.6 for green or bloody phlegm. A productive cough concurrent with upper respiratory tract symptoms can have physicians perceive that smokers have bronchitis requiring antibiotics. However, the clinical practice guidelines for bronchitis do not support the use of antibiotics,⁴¹ and this inappropriate antibiotic use for upper respiratory tract infections was estimated to cost patients \$726 million in 1998.⁴²

The potential limitations of this study include the disadvantages that accompany a retrospective medical record review. Incomplete or illegible documentation, variation in the quality of information in the record, and a lack of consistency among abstractors hinder accurate data abstraction. To deal with these limitations, a structured data abstraction form was used and abstractors were given a manual with specific instructions, trained via a conference call, and required to abstract 6 standardized medical records, with remediation given to those who required it.

Most of the data for this study were derived from EDs in urban centers affiliated with residency programs. This approach may hinder the ability to generalize the study's results to other ED settings. However, 15 sites not associated with academic EDs were included in the study to reduce this limitation. In addition, the lack of association between smoking and asthma severity found in this study may not differ among different ED settings. ED-based studies examine acute asthma presentations, which should be uniform across sites, whereas population-based studies focus on smoking and chronic asthma presentations, which can differ based on location and patient population.

Our definition of a current smoker (history of smoking cigarettes within 12 months before ED arrival) has some limitations. This selection of a 12-month period can allow patients who have quit smoking 6 months before ED presentation to be included in the current smoker category, causing it to be overly inclusive. However, less than 5% of community-based smokers actually quit within a given 12-month period,^{43,44} and the smoking rate observed in our study was similar to that obtained by Silverman et al.¹¹ These facts lend indirect support that most of our patients considered current smokers were most likely current smokers and not recent quitters. In addition, the potential inclusion of smokers in the nonsmoker group (because of the absence of smoking data in the medical record) would tend to attenuate differences between the groups (ie, to bias results toward the null). However, the number of smokers misclassified as nonsmokers would have to be large to cause variables that were not statistically significant, such as PEF, to reach statistical or clinical significance. This large of a misclassification seems unlikely, especially since we used a conservative definition for current smoker that included people who recently quit as current smokers.

Data were not available on the severity of smoking in individuals as defined by pack-years or cigarettes per day,

limiting the ability to interpret whether those who smoked more had more severe asthma exacerbations. The retrospective medical record review design only allowed data that were recorded in the records to be abstracted, which was smoking status, not the severity of smoking.

One-third of adult asthmatic patients treated in EDs smoked cigarettes, a prevalence much higher than the 21% found in the general adult population. This finding supports efforts to promote smoking cessation targeting patients with asthma. Smokers and nonsmokers did not differ in terms of asthma severity on presentation to the ED. However, smokers with asthma were more likely to receive antibiotics independent of age, even though antibiotics are not recommended in most patients with acute asthma or justified in patients reporting recent upper respiratory tract infections. The findings from this study emphasize the need to address the use of the ED visit for smoking cessation and an opportunity to curb inappropriate antibiotic dispensing in patients with asthma.

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