Physician adherence to the national asthma prescribing guidelines: evidence from national outpatient survey data in the United States

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Background: The Expert Panel 2 Guidelines for the Diagnosis and Management of Asthma (EPR-2 guidelines) were developed to improve medication prescribing for patients with persistent asthma and to control acute exacerbations of asthma. In addition, these guidelines also encourage physician-provided asthma education. Little is known about prescribing adherence to EPR-2 guidelines.

Objectives: To examine physician adherence to EPR-2 asthma medication prescribing guidelines and determine patient and physician factors associated with prescribing of asthma medications.

Methods: This study was a cross-sectional retrospective analysis of National Ambulatory Medical Care Survey physician visit survey data from 1998 through 2004. Data were extracted on all patients with an *International Classification of Diseases, Ninth Revision (ICD-9)* code for asthma (493.XX) and reason for visit as asthma. The unit of analysis was individual patient visit. The dependent variables in analyses were specific type of drug class. The independent variables were various patient and physician factors. Logistic regression analysis was used to evaluate study objectives.

Results: Asthma patients in 2002 had 3.3 times more odds of being prescribed controller medications compared with asthma patients in 1998. Findings in 2004 were not significant. Elderly patients had 54% less odds of receiving controller medication compared with those in the 35- to 64-year-old age group. Patients in the other race category are 40% as likely to receive controller asthma medication compared with white patients. Physicians in 2002 had 6.3 times more odds of prescribing long-acting β-agonists compared with those in 1998. Physicians without ownership stake in their practice had 1.9 times more odds of providing asthma education to their patients compared with those who owned their practice.

Conclusion: Physician prescribing of asthma pharmacotherapy does not adequately comply with EPR-2 treatment guidelines.

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INTRODUCTION

Asthma affects approximately 300 million persons worldwide.[1] In the United States approximately 14 million to 15 million people are reported to have asthma.[2,3] It is the most common chronic disease of childhood, affecting an estimated 4.8 million US children.[3] Direct and indirect medical costs associated with asthma care were estimated to be US $12.7 billion in 1998; $3.6 billion was spent on hospitalizations.[4] Pharmaceutical agents comprise a significant proportion of total asthma costs.[4,5] Asthma morbidity and mortality affect women, African Americans, and children disproportionately.[1–3,6–8] Antiasthma medications are the cornerstone of asthma treatment; judicious use of asthma pharmacotherapy may help to curtail increasing disease burden from asthma.

In 1995, the National Heart, Lung, and Blood Institute of the National Institutes of Health convened an expert panel under the auspices of the National Asthma Education and Prevention Program to review the advances made in the clinical management of asthma and to recommend additional guidelines to further improve the medical and pharmacotherapy management of asthma.[3] In 1997, new guidelines were published as the Expert Panel 2 Guidelines for the Diagnosis and Management of Asthma (EPR-2 guidelines). The EPR-2 pharmacotherapy guidelines emphasized that asthma pharmacotherapy should be used concurrently with environmental control measures to improve patient outcomes. The EPR-2 guidelines recommend using long-term controller medications to control asthma symptoms in patients with persistent asthma and to use short-term reliever medications to control acute exacerbations of asthma symptoms. Controller medications have a long duration of action and include corticosteroids, mast cell stabilizers or cromones, long-acting β-agonists (LABAs), long-acting methylxanthines, and leukotriene modifiers. Reliever medications have a short duration of action and include short-acting β-agonists (SABAs), anticholinergic agents, and systemic corticosteroids. EPR-2 guidelines also emphasized the use of anti-inflammatory medications, such as corticosteroids, leukotriene modifiers, and mast cell stabilizers, as first-line agents to treat the underlying chronic inflammatory processes in asthma. Furthermore, the

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EPR-2 guidelines highlighted the need for health care personnel to provide asthma education to their patients about the disease and treatment strategies to achieve satisfactory control of asthma symptoms.[3] The prescribing pattern of various antiasthma medications by physicians may indirectly help us identify whether the physicians are properly prescribing the medications and, hence, adhering to EPR-2 prescribing guidelines.

The overall aim of this study was to determine if there are specific predictors of asthma pharmacotherapy in the ambulatory population of the United States. This study aimed to shed light on 2 important issues: (1) whether physicians are adhering to EPR-2 guidelines and (2) identifying patient and physician factors that may be important predictors of asthma pharmacotherapy and significant to achieve greater compliance with the EPR-2 guidelines. Identifying these factors may help us improve patient outcomes in the ambulatory US population.

METHODS

This study was a cross-sectional retrospective analysis of the National Ambulatory Medical Care Survey (NAMCS) data from 1998 through 2004. Description of the NAMCS is provided elsewhere.[9] The NAMCS was an ideal database for this study because it contains physician and patient characteristics that may either help to improve physician and patient adherence to EPR-2 pharmacotherapy guidelines or serve to identify barriers to the successful adoption of these pharmacotherapy guidelines. Also, it may be possible to ascertain the temporal impact of guideline adherence and asthma pharmacotherapy.

Study Sample and Variables

The inclusion criteria for our study were all patients with a primary diagnosis of asthma (*International Classification of Diseases, Ninth Revision [ICD-9]* code 493.XX) and mention of the word *asthma* in the reason for the office visit. Patients with comorbid conditions (eg, chronic obstructive pulmonary disease, *ICD-9* code 492.XX) were excluded to avoid confounding. The study protocol was approved by the institutional review board at the Ohio State University.

Primary dependent variables used in these analyses were specific drug classes in the management of asthma. Controller medications are those with a long duration of action and include corticosteroids, mast cell stabilizers or cromones, LABAs, long-acting methylxanthines, and leukotriene modifiers. Reliever medications have a short duration of action and include SABAs, anticholinergic agents, and systemic corticosteroids. Dependent variables were categorical. For example, if the drug class was controller medications the dependent variable would be dichotomized as 1 (use of controller medications) and 0 (no use of controller medications). Table 1 lists several other classes of antiasthma drugs taken as dependent variables. The independent variables for the study were select patient and physician sociodemographic variables available in the NAMCS.

Statistical Analysis

Logistic regression models were built to identify predictors for each of the research objectives. The models were adjusted for patient and physician characteristics available in the NAMCS. For categorical variables, the Pearson χ^2 or weighted Wald test statistics were computed to determine significance of any association between the dependent variable and categorical variables.[10,11] For continuous variables in our models, we conducted univariate logistic regression analyses. After adding the variables that were considered significant, model assumptions were evaluated by looking at linearity in logit for continuous variable(s).[10] Since age seemed to have a quadratic relationship with each of the dependent variables in the models tested, it was collapsed into a categorical variable with 4 levels. Goodness of fit of the models was evaluated using Hosmer-Lemeshow test.[10] Analyses were performed with Stata statistical software, version 9.0.[12–14]

Table 1. Various Classes of Antiasthma Drugs Studied (Dependent Variables)

Controller medications	Reliever medications	Other
ICSs	SABAs	Anti-IgE
Oral corticosteroids	Oral corticosteroids[a]	
LABAs	Oral SABAs	
Leukotriene modifiers	Oral short-acting xanthines	
Inhaled cromones	Anticholinergic bronchodilators	
Oral LABAs	Combination of SABAs and anticholinergic bronchodilators	
Oral long-acting xanthines		
Combination of LABAs and ICSs[b]		

Abbreviations: ICSs, inhaled corticosteroids; LABAs, long-acting β-agonists; SABAs, short-acting β-agonists.

[a] The issue of the oral corticosteroid class in the analysis was complicated. Based on the nature of the National Ambulatory Medical Care Survey data set, it was difficult to ascertain whether these medications are in the controller or reliever medications group. Based on clinical knowledge, we decided to place this category in the reliever medications group. The oral corticosteroid category was also an independent variable in our analyses because it serves as a proxy for severity.

[b] The LABA and ICS combination includes both commercially available combination products such as Advair and also patients who are taking both an ICS and an LABA.

RESULTS

For the survey years 1998 to 2004, between 823.5 million and 910.9 million office visits were made in the United States, based on the weighted NAMCS estimates.[9] Tables 2 and 3 list demographic characteristics of patients and physicians, respectively. The mean age of asthmatic patients in the sample was 32.50 years (range, <1–96 years). There were more female patients (56%) compared with male patients. Most patients with asthma were white (82%) and of non-Hispanic origin (73%). Most patients (62%) were seen by primary care physicians, and 34% were being treated by pulmonary specialist physicians (allergists and pulmonologists). In terms of insurance coverage, 62% of patients had private insurance and 27% were covered by public insurance (Medicaid or Medicare). We estimate that 69% of the physicians who treated asthma patients in the sample were nonsolo practitioners and, hence, were more likely to be part of a group practice, whereas 74% of the physicians in the sample had an ownership stake (either full or part owners) of their practices. However, 79% of the physicians sampled also reported that their practices were either owned or managed by a managed care or health maintenance organization entity.

Table 4 presents only the significant variables from various logistic regression models. Reference categories in logistic regression models are year 1998, males, non-Hispanic patients, private insurance, family practice physicians, new and referred patients, physician or group owners of practice, and non–metropolitan statistical area. Severity of patients' asthma was measured using a proxy variable (ie, whether patients were prescribed oral corticosteroids). The reference category in the logistic regression models was patients with nonsevere conditions (patients not taking oral corticosteroids). Asthma patients in 2002 had 3.3 times (95% confidence interval [CI], 1.94–5.76) more odds of being prescribed controller medications when compared with patients in 1998. Elderly asthma patients (age ≥65 years) may have up to 54% (95% CI, 31%–95%) less odds of receiving controller medication when compared with the 35- to 64-year age group. Patients not belonging to the white or African American race have 40%

Table 2. Descriptive Characteristics of Patients[a]

Characteristic	Patients, %
Age, mean (range), y	32.50 (30.53–34.47)
Age group, y	
0–4	15
5–14	22
15–34	18
35–64	31
≥65	14
Sex	
Female	56
Male	44
Race	
White	82
Black	13
Asian	4
Native Hawaiian/Pacific Islander	0.61
American Indian	0.07
Other	0.22
Ethnicity	
Non-Hispanic	73
Hispanic	12
Unknown	15
Severity	
Taking oral corticosteroids	6
Not taking oral corticosteroids	94

[a] Because of rounding effects and the omission of missing data values, some of the proportions listed above may not sum to 100%. The proportions are based on the weighted sample. All data are proportions unless otherwise indicated.

Table 3. Descriptive Characteristics of Office-Based Physicians[a]

Characteristics	Physicians, %
Referral status	
Yes	12
No	47
Unknown	42
Patient status	
New	91
Old	8
Unknown	1
Physician specialty	
General practitioner/family medicine	20
Internal medicine	14
Pediatrics	27
Pulmonary specialties	34
Other	4
Insurance status	
Private insurance	62
Public insurance (Medicare or Medicaid)	27
Other	11
Practice status: solo or practitioner?	
Yes	31
No	69
Owner physician	74
Employee physician	22
Contractor physician	4
Ownership status	
Physician or group ownership	4
HMO ownership	79
Other	17
Geographical area	
MSA	88
Non-MSA	12
Geographic region	
Northeast	22
Midwest	20
South	33
West	25

Abbreviations: HMO, health maintenance organization; MSA, metropolitan statistical area.

[a] Because of rounding effects and the omission of missing data values, some of the proportions listed may not sum to 100%. The proportions are based on the weighted sample.

Table 4. Logistic Regression Models: Significant Variables for Different Drug Classes

Independent variable	Odds ratio (95% confidence interval)	*P* value
Controller Medications		
Year 2001	2.834 (1.56–5.13)	.001
Year 2002	3.346 (1.94–5.76)	<.001
Year 2003	1.881 (1.04–3.37)	.04
Age ≥65 y	0.542 (0.30–0.95)	.03
Other races	0.405 (0.19–0.89)	.02
ICSs		
Patient status	1.987 (1.02–3.85)	.04
Internal medicine physician	2.345 (1.28–4.29)	.006
Other physician	0.265 (0.10–0.66)	.005
LABAs		
Year 2001	5.542 (1.93–15.84)	.001
Year 2002	10.495 (3.66–30.06)	<.001
Year 2003	5.975 (2.02–17.65)	.001
Year 2004	6.306 (1.98–20.02)	.002
Age ≥65 y	0.482 (0.25–0.91)	.02
Age 5–14 y	0.397 (0.17–0.90)	.03
Age 0–4 y	0.062 (0.01–0.23)	<.001
Other owner	0.302 (0.10–0.89)	.03
Leukotriene Modifiers		
Year 2001	3.940 (1.26–12.31)	.02
Year 2002	5.254 (1.75–15.76)	.003
Year 2003	3.569 (1.23–10.31)	.02
Year 2004	3.914 (1.32–11.52)	.01
LABA and ICS Combination		
Year 2001	2.799 (1.50–5.22)	.001
Year 2002	2.985 (1.63–5.46)	<.001
Age ≥65 y	0.488 (0.28–0.82)	.008
Other race	0.267 (0.10–0.70)	.008
Employee physician	2.484 (1.10–5.59)	.03
Contract physician	1.702 (1.14–2.52)	.009
Short-Acting β-Agonists		
Year 2000	2.704 (1.52–4.79)	.001
Year 2001	1.986 (1.06–3.69)	.03
Year 2003	2.371 (1.39–4.03)	.002
Year 2004	2.019 (1.19–3.42)	.009
Age ≥65 y	0.489 (0.29–0.80)	.005
Sex	1.345 (1.02–1.77)	.03
Other race	1.769 (1.02–3.04)	.04
Ethnicity	0.637 (0.42–0.96)	.03
Asthma Education		
Other owner	1.928 (1.08–3.42)	.02

Abbreviations: ICSs, inhaled corticosteroids; LABAs, long-acting β-agonists.

lesser odds (95% CI, 19%–89%) of receiving controller asthma medications when compared with white patients.

The prescribing of the inhaled corticosteroids (ICSs) has not increased substantially from 1998 because none of the odds ratios for the years after 1998 were statistically significant. Established patients have twice the odds (95% CI, 1.02–3.85) to be prescribed ICS agents than new patients to the practice. Additionally, other physicians (non–primary care or nonspecialty physicians) have 27% the odds (95% CI, 11%–66%) of prescribing ICSs to their asthmatic patients when compared with family practice or general practitioner physicians.

Physicians had 6.3 times more odds (95% CI, 1.99–20.02) of prescribing LABAs in 2004 when compared with 1998. Patients who are between 5 and 14 years old have 40% less odds (95% CI, 17%–91%) of being prescribed LABAs when compared with patients between the ages of 35 and 64 years. It was also found that physicians who have ownership arrangements that were not private, group practice, or managed care had 30% lesser odds (95% CI, 10%–90%) of prescribing LABAs when compared with physicians in private or group practice. Patients who had other comorbidities in addition to asthma had 1.6 times more odds (95% CI, 0.99–2.56) to be prescribed LABAs when compared with patients who just had asthma.

Patients seen in 2004 had 3.9 times the odds (95% CI, 1.33–11.53) of being prescribed leukotriene modifiers than were patients seen in 1998. Patients in 2002 had almost 3 times more odds (95% CI, 1.63–5.46) of being prescribed a combination of LABAs and ICSs as were patients seen in 1998. An interesting finding in this model is that physicians who were employee physicians had 2.5 times more odds (95% CI, 1.10–5.59) than physicians who were owners or part owners of their practices of prescribing combination LABA and ICS therapy. Additionally, physicians who were contract physicians had 1.7 times more odds (95% CI, 1.14–2.53) of prescribing combination LABA and ICS therapy when compared with physicians who were owners or part owners of their practices.

Patients in 2004 had twice the odds (95% CI, 1.19–3.42) of being prescribed a SABA when compared with patients in 1998. Elderly patients had 49% less odds (95% CI, 30%–80%) of being prescribed SABAs when compared with patients between the ages of 35 and 64 years. Female patients had 1.3 times more odds (95% CI, 1.02–1.77) of being prescribed a SABA when compared with a male patient.

The only significant finding in the logistic regression model estimated to analyze the impact of asthma education was the ownership status of the practice. Physicians who did not have an ownership stake in their practice or who were not practicing for a managed care company had 1.9 times more odds (95% CI, 1.09–3.42) of providing asthma education to their patients when compared with practices in which the physician was the owner or part owner or if the physician's practice was owned by a managed care entity.

DISCUSSION

The overarching goal of this study is to determine if the prescribing of asthma pharmacotherapy by physicians is adherent to the EPR-2 guidelines. Physicians appeared to be increasing adherence to the EPR-2 guidelines with more prescribing of controller medications in 2002. Elderly patients are more likely to be prescribed controller medications. This observation is consistent with the findings of other studies.[7,15] Elderly patients may be at higher risk of develop-

ing significant mortality and morbidity from asthma, and this finding lends credence to that observation. It may be that physicians are reluctant to prescribe some of these controller medications because these patients may have concomitant cardiovascular diseases or other conditions such as glaucoma that may be aggravated by the use of asthma controller medications. Additionally, physicians may not recognize the level of severity of asthma in elderly patients as a result of these other concomitant diseases. The implication of this observation is that it is imperative to educate physicians on the importance of careful diagnosis, appropriate drug selection, and dosing of asthma medications in this population. Patients not belonging to the white or African American race (ie, other race patients) were more likely to be prescribed controller medications. Most patients in this category are of Asian origin. An explanation for this finding may be that there is difficulty in reaching this minority group because of language barriers or health beliefs.

A major finding from the review of the logistic models that were created in this study was that overall physicians do not seem to be adherent to the EPR-2 guidelines. Our analysis shows that the use of controller medications had started to decline after 2003. No significant change was found in the use of ICSs. Established patients were more likely to be prescribed ICSs. Physicians may be reluctant to prescribe ICSs to new patients without first evaluating the patient's asthma severity. A determination of the patient's asthma severity level may require several visits, and this factor may explain this observation. However, the EPR-2 guidelines recommend a more aggressive stepped care approach to controlling asthma symptoms.[1,3] This observation may indicate that physicians may be overtly cautious and tentative in the prescribing of these agents. The reason for non–primary care or nonspecialty physicians' prescribing of ICSs may be that they are not familiar with EPR-2 guidelines or may be that they are concerned about the side effect profile of ICS agents. The rate of prescribing ICSs by pediatricians does not appear to be different when compared with that of family practice or general practitioner physicians. This finding may indicate that pediatricians may be adhering to EPR-2 guidelines by not being overtly concerned with potentially serious adverse effects of ICSs in children.

Physicians may be preferentially prescribing LABAs to control chronic asthma symptoms rather than using ICSs as the primary controller agents. Given the potential risk of long-term LABA use and the demonstrated long-term effectiveness of ICSs, this behavior may be counterproductive in the long run. Since LABAs were only introduced in 1994 to 1995, the observation may represent a delayed uptake of this treatment option by physicians. However, physicians may perceive that LABAs may provide their patients with a better quality of life, given the attendant fears of potentially serious adverse effects from ICSs.[1,3] Children up to 14 years old were less likely to be prescribed LABAs. An explanation for this could be that LABAs are generally indicated for older patients. Safety and efficacy studies on the agents currently in the market are not sufficient for children younger than 5 years, and physicians may be reluctant to prescribe these agents for pediatric patients.[16,17] Additionally, these products are only available as dry powder inhalers, and young children may have difficulty in using this type of drug delivery system.[16,17]

It is also apparent from the results that leukotriene modifiers have become important and popular asthma pharmacotherapy agents during the past few years. Their safety profile, ease of use, and good clinical activity make them excellent agents for use in milder forms of the disease. However, we did not find a similar relationship with prescribing patterns for the combination of LABAs and ICSs. Fluticasone propionate was only approved by the Food and Drug Administration in 2000 and for ages 12 years and older at that time. This could potentially explain the pattern of adoption of these medications by the physicians. Because of the insufficient data on pediatric patients, physicians may have prescribed these agents less frequently and mainly to adult patients. Combination LABA and ICS therapy was prescribed more by employee or contract physicians. This finding may suggest that these physicians' prescribing behaviors or physician prescribing autonomy may be conditioned by the entities they work for. These entities may be managed care organizations or institutional providers such as academic medical centers that may adhere to evidence-based clinical guidelines such as the EPR-2. These entities may enforce strict formulary controls through certain regulated prescribing practices to ensure that physicians employed by them or who are contracted by them adhere to these guidelines.

Physicians continue to prescribe SABAs frequently, in contravention of the EPR-2 guidelines. Elderly patients were less likely to receive these agents. This finding may reflect physician concern about the risk for cardiovascular effects due to SABA use in elderly patients.[1,3] However, it may also mean that elderly patients, especially elderly patients who have more severe disease and potentially more exacerbations, may not be adequately managed and may be at higher risk for morbidity and mortality from asthma. Physicians who did not have an ownership stake in their practice were more likely to provide asthma education to the patients. It may be that most physicians had a socially desirable response to this query. There was no attempt to determine either the extent or quality of the patient education provided. Clearly, more research should be conducted to address both the quality and depth of patient education offered to asthma patients.

There may be structural issues that impede physicians from adhering to EPR-2 guidelines, such as cost of the medications, physician concerns about the safety profile of various agents, formulary challenges, patient noncompliance with the use of different asthma medications, and lack of physician knowledge of the utility of the use of various classes of medications. Patients, caregivers, and physicians should be educated on the judicious utility of various antiasthma agents in the long-term management of the asthma patient. A major finding from this study is that patients who are races other

than white or African American may receive suboptimal asthma pharmacotherapy. Although advances have been made in addressing the racial disparities in the management of asthma particularly between white and African American patients, it appears that sufficient attention has not been paid to minorities. It is imperative that the needs of this asthma population be met by crafting culturally specific interventions tailored for this group of patients. This population may be strongly influenced by community leaders and health care practitioners in their communities. Efforts should be made to recruit and train community activists to target these patients and to educate these patients about their asthma.

A major limitation of this study is the fact that we had used a public access, national database (NAMCS) as our primary data source. The NAMCS does not capture all the relevant physician and patient demographic variables that may affect prescribing behavior. The NAMCS data set is based on a retrospective cross-sectional sampling design. There is no longitudinal follow-up of patients and physicians sampled. Additionally, the retrospective nature of the analyses may not be applicable to prescribing patterns observed today, given the rapid introduction of new agents into the asthma pharmacotherapy in recent years. The NAMCS is reliant on self-report and subject to recall bias. We lack clinical variables in our analysis, such as diagnostic information that could identify the severity level of the patients in our analyses or outcome information such as activity restricted days, frequency of exacerbations, hospitalizations, and emergency department visits. We were unable to verify the accuracy of patients' diagnosis based on the *ICD-9* codes because of the lack of clinical evidence in the NAMCS. Conditions such as bronchitis, postinfectious bronchospasm, cough, cough-variant asthma, chronic obstructive pulmonary disease, and cystic fibrosis can cause wheezing and may have been misdiagnosed as asthma and, hence, wrongly classified. We attempted to use a proxy variable for patient severity (use of systemic corticosteroid agents) but that attempt failed. The only risk adjustment variable we used in our analyses was the presence of other comorbidities. We are missing variables that explain the impact of patient adherence and self-monitoring behavior, as well as variables that serve as barriers to physician guideline adherence. Our analyses do not include patients who visit emergency departments for their asthma care. For many patients, especially poor patients, the emergency department of hospitals in their only source of asthma care.

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