Treatment Patterns Among Adult Patients With Asthma

Factors Associated With Overuse of Inhaled β-Agonists and Underuse of Inhaled Corticosteroids

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Background: Overuse of inhaled β-agonists and underuse of inhaled corticosteroids by patients with asthma may have adverse consequences. This study was performed to identify factors associated with misuse of these types of asthma medication.

Methods: We examined baseline data from a longitudinal survey of adult patients with asthma. The setting was a consortium of 15 national managed care organizations serving 11 large employers. Baseline surveys were completed by 6612 health plan enrollees at least 18 years old who had had at least 2 visits with a diagnostic code for asthma in the preceding 2 years. The main outcome measures were the overuse of inhaled β-agonists and the underuse of inhaled corticosteroids. Independent variables were patient and process of care factors.

Results: Among patients with moderate or severe asthma, 16% of users of inhaled β-agonists reported overuse (>8 puffs per day on days of use), and 64% of users of inhaled corticosteroids reported underuse (use on ≤4 days/wk or ≤4 puffs per day). Overuse of inhaled β-agonists was most strongly associated with concomitant treatment with inhaled corticosteroids or anticholinergic agents, increased asthma symptom severity, problems in obtaining asthma medication, and male sex. Underuse of inhaled corticosteroids was associated with nonwhite race, younger age (18 to 34 years), lower use of inhaled β-agonist, lower symptom severity, and not possessing a peak flow meter. Rates of misuse of medication also varied by speciality of the patient's provider (generalist, allergist, or pulmonologist).

Conclusions: Overuse of inhaled β-agonists may be caused by symptom severity, while underusers of corticosteroids may interrupt use as symptoms abate. This study demonstrated an important opportunity to improve medication use among patients with asthma.

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ASTHMA IS a common disease characterized by inflammation of the airways and reversible obstruction to airflow. The annual economic burden of asthma in the United States was recently estimated to be $5.1 billion.[1] In 1997, more than 30.5 million prescriptions for asthma medications were filled, and patients had approximately 1.2 million emergency department visits and 445 000 hospitalization days.[1] While the disease has substantial impact on health care costs and patient morbidity, there are effective treatments and interventions to control symptoms of asthma and to prevent acute care visits. The National Asthma Education and Prevention Project (NAEPP)[2,3] and international guidelines[4] have emphasized the appropriate use of pharmacotherapy, including greater use of anti-inflammatory medications to control symptoms and the judicious use of inhaled rescue medications for short-term relief. These recommendations are grounded in the medical literature. Clinical trials and observational studies have shown that inhaled corticosteroids (ICSs) in adequate amounts prevent asthma symptoms, improve pulmonary physiological characteristics, and may reduce resource use for asthma attacks[5-8]; observational studies have shown that overuse of inhaled β-agonists is associated with death and near death.[9,10]

Present guidelines represent standards of care to achieve optimal outcomes. However, little is known about why these guidelines are not always followed. Understanding the factors associated with medication misuse would allow interventions to improve compliance with guidelines and to improve patient outcomes.

This study examines the appropriateness of prescription drug use in an adult population with asthma. Specifically, we examined overuse of β-agonist metered-dose inhalers (MDIs) and underuse of ICSs by means of data from a multisite

SUBJECTS AND METHODS

STUDY DESIGN

This analysis used patient-reported data from the baseline year of a 2-year cohort study to examine associations of overuse of inhaled β-agonist MDIs or underuse of ICSs with various patient and process-of-care factors.

STUDY POPULATION

The Managed Health Care Association Outcomes Management System Consortium Asthma Study was undertaken by 11 large employers and their managed care partners to test the feasibility and usefulness of patient-reported information to improve the quality of patient care.[11] Fifteen managed care organizations (MCOs) participated in a prospective longitudinal study that included an initial patient baseline survey and 2 annual patient follow-up surveys.

Study participants were selected from the pool of enrollees in each MCO by means of claims data or other central information sources. Three inclusion criteria were applied: (1) age 18 years or older on September 1, 1993; (2) enrollment in the MCO at the time of sampling; and (3) 2 or more medical care encounters (outpatient visits or hospitalizations) with a diagnosis of asthma (*International Classification of Diseases, Ninth Revision, Clinical Modification,* code 493.xx) from September 1, 1991, through August 31, 1993. The sampling pool was divided into 2 strata: (1) those who had at least 1 hospitalization or emergency department visit during the past 24-month period, and (2) those who had all of their asthma contacts in outpatient settings. From each of these groups, at least 300 patients were selected from each health plan. If fewer than 300 patients had hospitalizations or emergency department visits, then the outpatient group was expanded so that the total baseline sample numbered at least 600 patients. Individuals were excluded from the baseline assessment if they stated that they did not have asthma, or had disenrolled or expected to disenroll before January 1, 1994.

DATA COLLECTION

In August 1993, 10 539 patients were sampled, of whom 8640 were eligible for the study. Reasons for ineligibility included not having asthma (844 patients), disenrollment (839), and other (216). From September 1 through December 31, 1993, data were collected from patients by mail survey with telephone follow-up of nonresponders. The completion rate for the baseline survey was 76.9%, with 6612 usable questionnaires available for analysis.

DEFINITIONS

Our definitions of underuse and overuse were based on national and international guidelines.[2,4] Contemporary guideline-directed therapy emphasized use of inhaled β-agonists no more than 4 times daily and the use of a steady, moderate dose of ICSs adjusted as needed to achieve symptom control. We defined overuse of β-agonist MDIs as self-reported use of more than 8 puffs per day on days that patients used the medication. The reference group for analysis was patients who used β-agonist MDIs, but reported using 8 or fewer puffs per day. Underuse of ICSs was defined either as use on 4 or fewer days per week, or 4 or fewer puffs per day during the previous 4 weeks. The comparison group was patients using the ICSs on 5 or more days per week or 5 or more puffs per day. Analyses of underuse of ICSs were confined to patients with moderate or severe asthma (definitions of severity provided below) to ensure a study population for whom the guidelines clearly recommend ICS use.

VARIABLES

The dependent variables were self-reported overuse of inhaled β-agonists and underuse of ICSs. Independent variables were as follows.

Patient Demographics

Demographic variables included sex (male or female), age (18-34, 35-64, or ≥65 years), race (white or nonwhite), educational attainment (eighth grade or less, some high school, high school graduate, some college, college graduate, or any postgraduate work), and employment status (working full time, working part time, unemployed, keeping house, attending school, disabled, or retired).

Symptoms

Asthma symptom questions were based on the symptom types and frequencies used by NAEPP[2] and international[4] asthma guidelines and included cough, sputum, chest tightness, wheezy or whistling sound in the chest, and shortness of breath (never, once per week or less, 2 to 3 times a week, 4 to 5 times a week, or daily). Patients were asked how many times asthma had awakened them from sleep in the past 4 weeks (never, once, 2-4 times, 5-7 times, or 8 or more times), how frequent asthma attacks were in the past 4 weeks (not at all, less than once a week, once or twice a week, 3 or more times a week), and how their breathing was in between attacks (no problems, some symptoms on some days, some symptoms on most days, or symptoms most of the time). Patients also reported how much asthma had caused them to rearrange or cancel normal activities in the past 4 weeks (not at all, a little bit, some, or quite a bit) and had caused emotional problems in the past 4 weeks (not at all, a little bit, some, or quite a bit). An Asthma Symptom Index was created on the basis of the answers to 7 symptom questions (chest tightness, wheezing, shortness of breath, cough, sputum production, nocturnal symptoms, and persistence of symptoms between attacks[12]). The responses to each item were summed and divided by the number of nonmissing values. The range is 1 to 5, with a higher score indicating more symptoms.

Symptom Severity

In certain portions of the results, we report findings in patients who we classified as having mild, moderate, or severe symptoms. Our definition of asthma severity represents a synthesis of NAEPP[2] and International Consensus Report on Diagnosis and Management of Asthma[4] definitions of asthma severity and operational definitions used at Harvard Pilgrim Health Care, Brookline, Mass. It is based on patient

Continued on next page

reports of the frequency of symptoms (wheezing, chest tightness and shortness of breath), the frequency of nocturnal symptoms, and the chronicity of symptoms (**Table 1**). The severity classification was determinedby the greatest severity in the responses to any of these 5 questions (Diane E. Campbell, ScD, A.W.W., Yutaka Yasui, PhD, E.A.S., D.M.S., unpublished data, August 1997).

Comorbidity

Comorbid conditions were reported by patients as present or absent, including sinusitis, heartburn, congestive heart failure, chronic bronchitis, and emphysema. These conditions were selected as potential causes of worsening asthma, or illnesses with symptoms that overlap those of asthma.

Drug Treatment

Indicators of drug treatment included whether medications of certain classes were used by patients. Medication classes included β-agonist MDIs, anticholinergic and cromolyn sodium inhalers, ICSs, theophylline, oral corticosteroids, and oral β-agonists. Use of ICSs was assessed for days of use within a week (none, <1, 1-2, 3-4, 5-6, or 7 days) and daily dose (1-4, 5-8, 9-12, or >12 puffs per day). β-Agonist MDI use was quantified as puffs per day on days of use (1-4, 5-8, 9-12, or >12). Other indicators included whether a patient possessed a peak flow meter, had been shown how to use it, and had received instructions regarding what to do if the peak flow fell below a specified level, and frequency of use.

Access to Care

Access to care for patients with an acute asthma problem was assessed by trouble reaching a physician or nurse by telephone (yes or no), getting an appointment to see a physician (yes or no), or getting medication for asthma (yes or no).

Patient Knowledge

Knowledge was assessed by whether patients believed they had been given enough information by the physician or nurse to report knowing everything "you need to know" about what to do "when you have a severe flare-up of your asthma," how to "adjust medicine when your asthma gets worse," and what "things can make your asthma worse and how to avoid them." Patients also rated their own knowledge about what to do in a severe asthma attack (knowledge was rated on a 5-point scale, with 1 indicating poor; 5, excellent).

Physician Specialty

The patient was asked to name the physician primarily responsible for managing his or her asthma, and to give the physician's specialty. Specialty was categorized as generalist (internist or family practitioner), allergist, or pulmonologist.

Satisfaction With Care

Satisfaction with care was assessed (5-point scale, with 1 indicating poor; 5, excellent) in the following areas: length of time to wait for a physician appointment, ease of reaching a physician or nurse by telephone, ease of getting urgent or emergency care, quality of communication with physicians and nurses, skill of physicians, how much the patient had to pay out of pocket for asthma care, and an overall satisfaction rating.

Health Care Utilization

Health care utilization for asthma was assessed by the number of office visits in the past 6 months, telephone calls to the physician in the past 6 months, emergency department visits in the past year, and hospital admissions in the past year.

Health Plan Type

The MCO in which the patient was enrolled was categorized as an independent practice association health maintenance organization, a preferred provider plan, a staff-model health maintenance organization, or a mix of 2 or more of these types. The classification was based on the dominant product type offered to study participants by the MCO and the delivery model type.

STATISTICAL ANALYSIS

Variables were examined by descriptive frequencies and cross-tabulations. Bivariate analyses were performed by means of *t* tests for continuous variables and χ^2 tests for categorical items. Differences were reported as statistically significant if they had a *P* value less than .05. Items that were statistically significant in bivariate analysis or that were considered clinically important were examined in multivariate models by logistic regression. Multivariate models were developed in each sampling stratum (inpatient and outpatient); because there were no important differences between the two, a model combining all patients is reported. Results of the most parsimonious models are reported with odds ratios and 95% confidence intervals. Statistical computations were performed with SAS version 6.07 statistical software (SAS Institute, Cary, NC).

quality-of-care study, the Managed Health Care Association Outcomes Management System Asthma Project.

RESULTS

POPULATION DEMOGRAPHICS

Of the patients who completed the baseline survey, 70.0% were female and 81.9% were white, with a mean age of 44 years (range, 18-94 years). Nearly 62% had at least some college education, and 11.3% did not finish high school. More than 70% were employed full or part time, 1.8% were unemployed, and 6.3% were disabled.

DRUG TREATMENT PATTERNS

Patients reported using up to 7 different types of medication for their asthma (**Table 2**). For mildly symptom

atic patients, a majority (64.2%) reported using 1 or 2 types of medication (mean, 1.9; SD, 1.22), while patients with moderate or severe asthma commonly (51.1%) reported using 2 or 3 types of medication (mean, 3.0; SD, 1.52). Use of no medications was reported by 10.1% of mildly symptomatic patients and 1.6% of moderately or severely symptomatic patients.

β-Agonist MDIs were the most frequently used medication (**Table 3**), with use reported by 94.4% of patients with moderate or severe asthma. For patients with moderate or severe asthma, 66.6% reported using ICSs; 42.5%, theophylline preparations; 30.2%, oral β-agonists; 21.7%, oral corticosteroids; 11.6%, inhaled cromolyn; and 10.7%, inhaled anticholinergics.

The 10 most common drug regimens accounted for 58.9% of all patients surveyed (**Table 4**). The most common regimen was a β-agonist MDI with an ICS (17.4% of patients). The sixth most common regimen was no medications, and cromolyn and inhaled anticholinergics were not included in any of the top 10 regimens. More than 220 other combinations, none of which was reported by more than 2% of patients, were used by the remaining 41.1% of patients.

β-Agonists were overused by 15.8% of moderately or severely symptomatic patients and by 3.6% of mildly symptomatic patients (**Table 5**). Of the moderately or severely symptomatic patients who overused inhaled β-agonists, 10.7% were not using any type of corticosteroid (inhaled or oral), and only 4.5% were using no other medications. Of note, 42.7% of overusers of β-agonist MDIs with moderate or severe symptoms were also taking an oral β-agonist.

Sixty-four percent of patients with moderate or severe asthma were underusing ICSs. Thus, only 36.0% of the ICS users were using the medication on a regular basis. Since only 22.8% of patients with moderate or severe asthma symptoms were using an ICS, perhaps as few as 24.0% of patients were receiving a recommended dose.

Table 1. Severity Rating Criteria

Severity Level	Symptom Frequency	Nocturnal Symptoms	Symptom Chronicity
Mild	Mild symptoms, not more than once a week	Not more than once a month	Asymptomatic between exacerbations
Moderate	Exacerbations 2-5 times a week	2-7 times a month	Some symptoms on most days, requiring inhaler for relief
Severe	Frequent exacerbations, more than 5 times a week	Frequent nocturnal symptoms, more than 7 times a week	Symptoms most of the time

BIVARIATE ASSOCIATIONS WITH MEDICATION MISUSE

Overuse of Inhaled β-Agonists

Table 6 displays bivariate associations between the 2 dependent variables and other factors. β-Agonist overusers appeared to have more severe asthma by symptom and functional consequences, with more frequent respiratory symptoms, nighttime awakenings, asthma attacks, and canceled activities because of asthma. Overuse of β-agonist MDIs was significantly associated with lower educational attainment and being disabled (data not shown).

Analysis of indicators of treatment showed that overusers were more likely to have a peak flow meter, reported slightly greater levels of asthma knowledge, and reported greater use of their asthma medications, including ICSs.

Health care utilization was greater in β-agonist MDI overusers, and satisfaction with care was slightly greater. Overuse of β-agonist MDIs was more frequent in patients of pulmonologists than either generalists or allergists (**Table 7**) and was most frequent in preferred provider plans (17.8%) and least frequent in mixed plans (13.2%) (not shown).

Underuse of Inhaled Corticosteroids

Table 6 shows that underuse of ICSs was associated with being female, nonwhite, and younger and working full time (data not shown). The ICS underusers appeared to be less symptomatic and suffer fewer functional consequences of their asthma. Analysis of treatment indicators showed that underusers were less likely to have a

Table 2. Distribution of Number of Drug Types* Used by Asthma Severity

Asthma Severity	No. of Persons†	No. of Types, %							
		0	1	2	3	4	5	6	7
Mild	872	10.1	31.1	33.1	15.7	6.1	3.4	0.3	0.1
Moderate or severe	5718	1.6	14.1	27.3	23.8	16.5	10.3	4.5	1.4

β-Agonist metered-dose inhalers, inhaled corticosteroids, anticholinergic inhalers, cromolyn sodium inhalers, theophylline, oral corticosteriods, and oral β-agonists.

†Equal to 100%.

Table 3. Frequency of Medication Use by Medication Type

Asthma Severity	No. of Patients	Drug Type, % of Patients							
		β-Agonist MDI*	Inhaled Corticosteroid	Theophylline	Oral β-Agonist	Oral Corticosteroid	Other Inhaler	Cromolyn Sodium	Anticholinergic Inhaler
Mild	872	83.0	48.2	20.3	12.4	5.3	5.8	6.2	3.7
Moderate or severe	5718	94.4	66.6	42.5	30.2	21.7	12.2	11.6	10.7

**MDI indicates metered-dose inhaler.*

Table 4. Frequency of Medication Use by Regimen

Regimen Rank	% of Patients†	Drug Type*							
		β-Agonist MDI	Inhaled Corticosteroid	Theophylline	Oral β-Agonist	Oral Corticosteroid	Other Inhaler	Cromolyn Sodium	Anticholinergic Inhaler
1	17.4	X	X						
2	14.4	X							
3	7.6	X	X	X					
4	3.7	X		X					
5	3.6	X	X	X	X				
6	3.0								
7	2.7	X	X	X	X	X			
8	2.2	X			X				
9	2.2	X	X		X				
10	2.1	X	X				X		

*An X indicates that the drug in that column was given as part of the regimen in that row. MDI indicates metered-dose inhaler.
†Total, 58.9%.

Table 5. Distribution of Number of Puffs per Day on Days When β-Agonist Metered-Dose Inhaler Was Used by Asthma Severity

Asthma Severity	No. of Persons*	No. of Puffs per Day, %		
		≤8	9-12	>12
Mild	691	95.4	3.0	0.6
Moderate or severe	5330	84.2	10.8	5.0

*Equal to 100%.

peak flow meter, had less knowledge about asthma, and were less likely to use other asthma medications.

With regard to health care utilization, ICS underusers were less likely to have hospital or emergency department use in the preceding year, and satisfaction with care was generally lower.

Underuse of ICSs was more likely in patients of generalists than of either pulmonologists or allergists, and significantly more likely in patients of allergists than pulmonologists (Table 7). Underuse of ICSs was most common in mixed plan types (67.1%) and least common in preferred provider organizations (58.9%) (not shown).

MULTIVARIATE ANALYSES

Associations With β-Agonist Overuse

After adjustment of symptom severity and demographic factors, overusers of β-agonist MDIs were more likely to use ICSs (**Table 8**). They were also more likely to report problems getting medicine for asthma. Overuse was still more likely in patients of pulmonologists, but less likely in patients of allergists, compared with patients of generalists. The Asthma Symptom Index score was significantly associated with overuse of β-agonist MDIs, suggesting that medication overuse was driven by symptoms.

Associations With ICS Underuse

After adjustment, underusers of ICSs were less likely to have peak flow meters and used less inhaled β-agonists (**Table 9**). Underuse was significantly less common in patients of both allergists and pulmonologists compared with generalists.

COMMENT

In this study, nearly two thirds of patients with moderate or severe asthma reported using less ICS than recommended in the guidelines, while 1 in 6 reported overusing β-agonist MDIs. Of particular concern is the high rate (43%) of moderately or severely symptomatic overusers of β-agonist MDIs who simultaneously used an oral β-agonist, possibly further increasing the risk of drug toxic effects. Although the current study was performed before the release of the 1997 NAEPP guidelines,[3] it is worth noting that a greater proportion of these patients might now be considered β-agonist overusers, as the latest guidelines consider daily use or increasing use as indicative of the need to increase the intensity of medical therapy.

In general, patients who used more β-agonist MDIs appeared to be sicker in terms of symptoms and resource use. Respondents with moderate or severe asthma were more likely to use ICSs, although a substantial number appeared to be using too little ICS. A priori, we expected that overusers of β-agonist MDIs would have fewer markers of good-quality asthma care. Instead, we found that patients who overused β-agonist MDIs were more likely to use each of several other classes of medication, to have a peak flow meter, and to report higher levels of satisfaction with care. Patients who used ICSs in lower doses tended to be less symptomatic and to use fewer resources. However, they were also less satisfied with their asthma care and had less asthma education. Although they had fewer symptoms, they were not symptom free, suggesting opportunities to improve the quality of care in this subgroup. Although not all of the same patient and care factors were associated with medication misuse in the 2 models (β-agonist and ICS), the overlap of several factors associated with disease severity suggests that greater use of medications is strongly influenced by greater severity or poorer symptom control.

Of note, patterns of patient-reported drug usage were independently related to physician provider type. Other

Table 6. Bivariate Associations of Overuse of β-Agonist MDIs and Underuse of ICS With Demographic, Treatment, and Outcome Indicators*

	β-Agonist MDI, %		ICS, %	
	Overuse	No Overuse	No Underuse	Underuse
No. of patients	868	5158	1523	2712
Demographics				
Age, y				
18-34	24.7	27.9	20.4†	27.5
35-64	65.4	64.1	68.0	65.6
≥65	9.9	8.0	11.6	6.9
Sex				
M	34.4‡	29.1	33.0†	25.8
F	65.6	70.9	67.0	74.2
Race				
White	84.6§	81.5	90.0†	81.4
Nonwhite	15.4	18.5	10.0	18.6
Asthma impact				
Symptoms (≥2-3 times/wk)				
Cough	67.9†	51.9	60.4†	54.3
Sputum	62.0†	45.2	55.2†	46.9
Chest tightness	79.2†	52.1	66.5†	54.8
Wheezing	77.8†	53.0	62.5†	56.8
Shortness of breath	85.3†	58.8	73.6†	60.9
Night awakening	74.1†	44.5	59.4†	47.8
Asthma Symptom Index score, mean (range, 1-5)	3.54†	2.70	3.12†	2.78
Attacks (≥1-2/wk)	69.9†	42.2	56.6†	44.6
Canceled activities because of asthma	92.7†	77.0	87.1†	78.6
Emotional problems from asthma	68.4†	45.7	57.9†	48.0
Symptoms most of the time between attacks	25.5†	7.3	18.8†	6.9
Control of asthma rated very good or excellent	24.4†	45.3	37.4†	43.1
Treatment indicators				
PFM				
Has PFM	40.2†	24.4	44.4†	27.4
Taught to use PFM	98.0‡	94.0	96.1	94.4
Knows action to take at low reading	81.7§	76.7	79.2	77.9
Knowledge				
Managing flare-ups	54.8	52.8	62.0†	54.2
Recognizing triggers	55.3	52.3	53.5†	59.8
Adjusting medications	53.3	49.7	58.2†	51.3
Cromolyn sodium	17.4	10.8	17.3	11.6
Corticosteroid MDI (any)	83.9†	66.0	100.0	100.0
Corticosteroid MDI used daily	54.6†	29.9	91.9†	26.7
Corticosteroid MDI >4 puffs/d	34.6†	6.2	. . .‖	. . .
β-Agonist MDI (any)	100.0	100.0	98.0§	96.7
β-Agonist MDI >8 puffs/d	. . .	. . .	30.5†	10.6
Theophylline	59.0	38.2	54.5	39.9
Oral β-agonist	42.7	26.8	35.4	28.7
Oral corticosteroids	39.6	17.2	34.6	19.0
Anticholinergics	21.5	8.7	17.8	10.2
Comorbidity				
Heartburn	40.9†	32.1	39.0†	31.6
Sinusitis	48.2	45.2	49.3	46.1
Chronic bronchitis	34.8†	24.6	29.3‡	24.6
Emphysema	12.8†	4.4	8.4†	4.1
Utilization				
ED visits for asthma (≥3 in past year)	15.4†	6.5	10.6†	7.4
Office visits for asthma (≥4 in past 6 mo)	36.7†	17.8	32.9†	20.3
Telephone calls to physician about asthma (≥4 in past 6 mo)	46.4†	24.3	39.4†	28.2
Hospital admissions for asthma (≥1 in past year)	20.2†	9.4	14.7†	10.8
Access (excellent or very good rating)				
Time to get appointment	64.6	64.2	69.6†	65.6
Ease of reaching physician by telephone	66.4	66.4	72.3†	66.1
Ease of getting urgent care	71.3†	70.6	76.3†	69.8
Quality of communication	65.1†	62.6	71.0†	63.2
Skill of physician	70.7‡	68.0	76.8†	67.8
Payment for asthma care	45.8†	52.3	53.4	51.0

**MDIs indicates metered-dose inhalers; ICS, inhaled corticosteroid; PFM, peak flow meter; and ED, emergency department.*
†P<.001.
‡P<.01.
§P<.05.
‖Not shown.

studies have examined knowledge, practice style, and outcome differences among specialists compared with generalists for asthma and other diseases. Our study compared 2 subspecialty types with generalist physicians. We found that ICS underuse was more likely in patients of generalists, even after patient characteristics, symptom severity, number of office visits, and other treatments were considered. Similarly, patients of allergists were less likely to overuse β-agonist MDIs, but patients of pulmonologists were more likely to overuse β-agonist MDIs than were patients of generalists. These findings may reflect disease severity not captured by indirect measures, or they may reflect practice differences between specialty type that resulted in different degrees of symptom control. It will be important to investigate differences in practice style to learn if allergists offer some advantage in delivery of care to patients with asthma. Also of note is the finding in multivariate analyses that the plan type in which physicians practiced had no significant independent effect on the likelihood of medication misuse.

Since the 1960s, investigators have found associations between the use of certain medications and adverse outcomes of asthma.[9,13,14] Speizer and his colleagues[9] found that a large proportion of patients with asthma who died of asthma in the United Kingdom had used corticosteroids and inhaled bronchodilators. Recent studies have fueled the controversy over whether inhaled β-agonists are responsible for poor asthma outcomes or are merely markers of severe or uncontrolled disease.[10,15] A recent study, using the Saskatchewan prescription database, showed an association between beneficial outcomes and ICS use. In particular, compared with nonusers, users of a modest dose

Table 7. Bivariate Associations of Overuse of β-Agonist Metered-Dose Inhaler (MDI) and Underuse of Inhaled Corticosteroid (ICS) With Provider Specialty

		β-Agonist MDI, %*		ICS, %†	
	No. of Patients	Overuse	No Overuse	No Underuse	Underuse
Pulmonologist	1296	19.5	80.5	46.2	53.8
Allergist	3331	8.6	91.4	41.2	58.8
Generalist	930	14.4	85.6	31.4	68.6

**Pulmonologist vs generalist:* P<*.001; generalist vs allergist:* P<*.001; pulmonologist vs allergist:* P<*.001.*

†Pulmonologist vs generalist: P<*.001; generalist vs allergist:* P<*.001; pulmonologist vs allergist:* P<*.05.*

Table 8. Associations With Overuse of β-Agonist Metered-Dose Inhaler*

Category	Variable	OR (95% CI)
Demographics	Male sex	1.48 (1.24-1.78)†
Asthma impact	Canceled activities because of asthma	1.63 (1.19-2.23)†
	Awakened by asthma	1.17 (1.08-1.26)†
	Asthma Symptom Index score	1.67 (1.49-1.88)†
Treatment	Inhaled cortiosteroid	1.87 (1.51-2.33)†
	Anticholinergic inhaler	1.74 (1.39-2.19)†
	Theophylline	1.44 (1.21-1.72)†
Education impact	Recognizing triggers	1.16 (1.03-1.31)
Utilization	Hospitalization in past year for asthma	1.46 (1.17-1.83)†
Access	Problem getting medicine for asthma	1.74 (1.39-2.18)†
Provider type (compared with generalist)	Allergist	0.61 (0.46-0.81)†
	Pulmonologist	1.21 (1.00-1.48)

**Variables shown are limited to those that were statistically significant in logistic regressions. OR indicates odds ratio; CI, confidence interval.*

†P<.01.

Table 9. Associations With Underuse of Inhaled Corticosteroids*

Category	Variable	OR (95% CI)
Demographics	Age 35-64 y (vs 18-34 y)	0.75 (0.63-0.90)†
	Age ≥65 y (vs 18-34 y)	0.48 (0.35-0.65)†
	Female sex	1.44 (1.22-1.71)†
	Nonwhite race (vs white)	1.90 (1.51-2.39)†
Asthma impact	Symptoms most of the time between attacks	0.51 (0.40-0.66)†
	Severity gradient	1.09 (0.99-1.20)
Treatment indicators	Peak flow meter at home	0.61 (0.52-0.72)†
	No. of puffs of inhaled bronchodilator	0.49 (0.44-0.54)†
	Oral corticosteroids in past month	0.73 (0.60-0.87)†
Utilization	No. of office visits for asthma in past 6 mo	0.87 (0.82-0.92)†
Provider type (compared with generalist)	Allergist	0.53 (0.43-0.66)†
	Pulmonologist	0.61 (0.51-0.73)†

**Variables shown are limited to those that were statistically significant in logistic regressions. OR indicates odds ratio; CI, confidence interval.*

†P<.01.

of ICS had a lower risk of death and near-death, while those who used a lesser amount had an increased risk.[6] Another recent study showed that use of ICSs was associated with a lower risk of hospitalization.[5] The current findings provide additional insight into patient and care factors associated with patterns of medication use.

There are several limitations to this study. First, our patients were typically young, white, employed, and female, and the sample was drawn entirely from people with some form of private insurance. In addition, the study sample was designed to overrepresent patients with moderate or severe asthma. Thus, the results may be less generalizable to patients receiving Medicaid or without health care coverage and to patients with mild disease. In contrast to a clinical trial, interpretation of an observational study, which examines the associations of treatment regimens with patient symptoms, may be confounded by disease or symptom severity. Thus, it is difficult to attribute outcomes exclusively to medications used. Unfortunately, there is no universally agreed-on measure of asthma severity, so even in multivariate analyses of asthma outcomes, one cannot determine whether adjustment for medication use is ideal, or whether it overadjusts or underadjusts for disease severity. A practical problem with imperfect measures of intrinsic asthma severity is that one cannot discriminate between patients who have more severe disease that is less responsive to therapy and those whose disease is inadequately controlled because of undertreatment. Patients with similar reports of symptom frequency and severity could include patients who are at their "personal best" on an optimized medical regimen as well as patients who are undertreated, either because of prescribing patterns of physicians or poor adherence to regimens. It is difficult, therefore, to judge the quality of an individual patient's drug regimen without detailed clinical data. Although some regimens may appear irrational or inconsistent with published guidelines, they could represent compromises or sacrifices to achieve patient compliance, or simply the best regimen for an individual patient, arrived at through trial and error.

The data we presented in this study were obtained by patient self-report. Patient reports more closely reflect the patient experience than do physician or administrative sources of data. Also, we are reassured about the classification of β-agonist MDI overusers and ICS underusers, since patients who do not report adherence accurately tend to self-report toward compliance.[16] In other words, patients tend to be accurate when they report use of medication that is higher or lower than prescribed, while some patients who report ideal usage are actually not using the medication as prescribed. This type of differential misclassification would tend to attenuate rather than exaggerate any differences we have shown.

We used a sampling strategy that involved 2 strata based on prior utilization patterns (hospitalization or emergency department visit vs outpatient). Because we attempted to draw similar-sized samples from underlying populations that almost certainly varied in size, the allocation to each stratum was not proportional. To examine whether this disproportionality affected conclu-

sions drawn from the multivariate models, we performed the regressions separately in each sampling stratum. There were no important changes in odds ratios by sampling stratum, so a combined model was shown. Since patients were clustered within MCOs, their responses were not entirely independent. This can lead to underestimates of the true SEs around survey responses. In situations where precise estimation is important, this problem can be handled by means of statistical adjustments for cluster sampling (eg, the Huber-White method[17] or mixed-effects models). However, since our analysis primarily concerned the relationship among putative correlates of treatment use, this problem is unlikely to change our conclusions.

These findings should not be used to single out managed care for criticism. Managed care was very broadly defined in our study, ranging from staff-model health maintenance organizations to independent practice associations and mixed-model MCOs that bear closer resemblance to fee-for-service practice. In fact, use of ICSs was closer to guidelines in staff-model MCOs than under other models, suggesting an association between more aggressive care management and guideline compliance. In addition, we have no data to compare these usage patterns with those of patients treated outside of managed care. As our data were collected in 1993, soon after release of the first version of NAEPP guidelines, follow-up work is needed to assess changes in treatment patterns over time. Thus, our results point to a more general need for quality assessment and improvement in asthma care in the United States.

Our findings have implications for development of quality indicators for asthma care. For example, it may not be sufficient to grade MCOs on the basis of whether a patient has received a prescription for an inhaled anti-inflammatory drug. A more refined measure would need to probe further to assess both prescription and actual use of medications for long-term control. On the other hand, patterns observed in this study may suggest potential indicators for screening for quality improvement, using pharmacy or other claims data. We have also shown the importance of case-mix adjustment[18] in the interpretation of medication use, as there are multiple patient and process of care factors that were independently associated with medication use and misuse.

This study demonstrates an opportunity in the MCOs represented to increase the use of long-term controller medications for adult patients with asthma, as well as to reduce the overuse of β-agonists. We have identified important factors that are independently associated with suboptimal medication use, making it possible to target subpopulations of adult patients with asthma who could benefit from increased scrutiny of their drug regimens. In addition, we have shown that suboptimal medication use varies by physician specialty type, which suggests the need to further study which factors of education, experience, and practice setting provide better patient treatment.

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