Use of the inhaled corticosteroid to bronchodilator ratio in an audit of the treatment of asthma in an academic family medicine residency programme

Paul Pisarik MD, MPH

ABSTRACT

INTRODUCTION: Asthma affects around 5% of the United States population, with 50% having uncontrolled symptoms.

AIM: To improve asthma care by seeing if the inhaled corticosteroid to bronchodilator ratio (RATIO) is associated with asthma control and if non-clinical factors were associated with adherence to asthma guidelines.

METHOD: A retrospective study using University of Oklahoma-Tulsa, School of Community Medicine Family Medicine Clinic electronic medical records of a random sample of 49 patients with asthma who were seen at least twice from July 2003 through June 2007 and did not have a diagnosis of chronic obstructive pulmonary disease or exercise-induced asthma.

RESULTS: The RATIO for those prescribed corticosteroid inhalers was directly related to the actual step of asthma care (STEP) but inversely related to the number of prednisone courses prescribed per year (R^2=.30, p=0.0012). The difference between the actual STEP and ideal STEP (had corticosteroid inhalers been prescribed for all the months in the study) was directly related to the percent of available salbutamol (albuterol) inhalers that non-clinicians refilled and inversely related to the actual STEP (R^2=.45, $p=1.8 \times 10^{-5}$). The available corticosteroid inhalers prescribed was directly related to the actual STEP and inversely related to the number of comorbid diagnoses addressed at the last asthma visit (R^2=.70, $p=5.8 \times 10^{-10}$).

DISCUSSION: Efforts to both limit salbutamol medications, especially by non-clinicians, and simultaneously prescribe appropriate amounts of inhaled corticosteroids, through a dedicated asthma visit, should improve asthma control. A higher RATIO implies better asthma control.

KEYWORDS: Asthma; anti-inflammatory agents; albuterol; bronchodilator agents; drug therapy, combination; medical audit

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CORRESPONDENCE TO:
Paul Pisarik
Assistant Professor
Family Medicine,
University of Oklahoma,
School of Community
Medicine, Tulsa, OK
74120-5440, USA
paul-pisarik@ouhsc.edu

Introduction

Asthma is a chronic airway inflammatory disease that affects 300 million people around the world.[1] In the Global Initiative for Asthma dissemination report, the prevalence of clinical asthma varied from 1.1% in Indonesia to 18.4% in Scotland, with the prevalence projected to increase as population shifts occur from rural to urban settings.[1] Despite guidelines from multiple organisations, studies have shown that 49% to 82% of patients with asthma have uncontrolled symptoms, as measured by Global Initial in Asthma (GINA) guidelines,[2] Canadian Asthma Consensus Guidelines,[3,4] an Asthma Control Test score of 5–19,[5,6] and National Asthma Education and Prevention Program (NAEPP) guidelines.[7,8]

Non-adherence is the major reason: clinicians to asthma guidelines and patients to medications.[9]

For the United States (US), the NAEPP guidelines recommend prescribing medications according to a six-step approach to control asthma (STEP).[10] Below are the preferred medications for patients 12 years of age and older:

a. **Step 1**—as needed use of short-acting ß$_2$ agonist (SABA);
b. **Step 2**—low-dose inhaled corticosteroid (ICS);
c. **Step 3**—medium-dose ICS or low dose ICS plus long-acting ß$_2$ agonist (LABA);
d. **Step 4**—medium-dose ICS plus LABA;
e. **Step 5**—high-dose ICS plus LABA, and consider omalizumab for patients with allergies;
f. **Step 6**—high-dose ICS plus LABA plus oral steroids, and consider omalizumab for patients with allergies.

In an effort to see how well clinicians are prescribing asthma medications, the inhaled corticosteroid to SABA prescribing ratio (RATIO) has been proposed as a measure of the quality of asthma medication prescribing. The higher the ratio, the better the patient's asthma control should be since the patients would be using relatively less reliever medication compared to controller medication.

The objective of this study was to see if there were opportunities for improved asthma management at the University of Oklahoma-Tulsa, School of Community Medicine, Family Medicine Clinic (OUTFM). The aims were two-fold:

1. See if RATIO is associated with objective data on an individual patient level that could indicate quality asthma prescribing; and

2. To explore relationships among clinical and non-clinical factors to see if there were opportunities for improved asthma care:

a. clinical:
   i. rate of prescription of asthma medications (all available including original prescription and refills);
   ii. oral prednisone prescriptions;
   iii. step of asthma therapy (STEP).

WHAT THIS GAP FILLS

What we already know: Over 50% of patients with asthma have uncontrolled symptoms. Using salbutamol (albuterol) more than twice a week (or one canister a year), according to the National Asthma Education and Prevention Program, is a sign of uncontrolled asthma, a fact not fully appreciated by clinicians or non-clinicians.

What this study adds: The number of available salbutamol (albuterol) inhalers prescribed, both for all the patients and as the denominator in the ratio of number of inhaled corticosteroids to albuterol in those patients prescribed inhaled corticosteroids, is associated with increased prednisone prescriptions a year. Efforts to both limit salbutamol prescriptions (especially by non-clinicians) and simultaneously prescribe appropriate amounts of inhaled corticosteroids (ideally thorough dedicated asthma visits) should improve asthma control.

b. non-clinical:
   i. patient demographics;
   ii. percent inhaler prescriptions refilled by non-clinicians (nurses and medical assistants who refill medications without the direct approval of a clinician); and
   iii. number of comorbid diagnoses at the last asthma visit.

Method

Study design

A retrospective study using OUTFM electronic medical records of patients diagnosed with asthma was conducted after obtaining ethics approval from the University of Oklahoma Health Sciences Center Institutional Review Board—number 13765.

Participants

A list of patients, 18 years of age or older, with at least one diagnosis of asthma (ICD-9 codes 493.00–493.92) from July 2003 through June 2007 was generated. The 976 patients (80.9% women) were then ordered by medical record number and every fourth patient was chosen for review with every 7th fourth patient unchosen. This led to exactly 200 patients (81.5% female) who were then divided equally among four family medicine resident reviewers. Since our population is heavily weighted towards government as-

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
18 years of age or older	Diagnosis of chronic obstructive pulmonary disease
2 visits for asthma between July 2003 and June 2007	Diagnosis of exercise-induced asthma

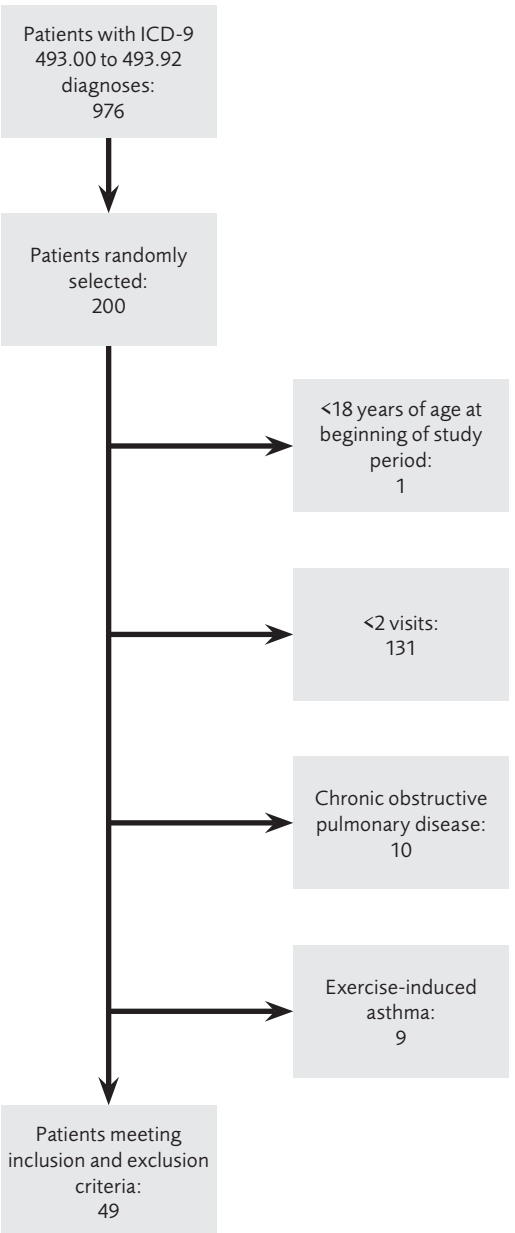
sistance (Medicaid), the majority of patients were women. Table 1 lists the inclusion and exclusion criteria. Of the 200 randomly selected patients, Figure 1 shows how 49 patients fulfilled all the inclusion and exclusion criteria.

Data collection

These 49 charts were then reviewed and the following data was obtained for each patient:

1. Age, ethnicity, gender, and payer source;
2. Number of available salbutamol, inhaled corticosteroid, and leukotriene receptor antagonist medications that could have been filled per year, i.e. original prescription and all refills with maximum of 11 refills, if refills were written 'prn', identified as ALB/yr, STER/yr, and LTRA/yr, respectively. The number of available inhaled doses per corticosteroid inhaler lasts exactly 30 days at the prescribed dose, so one inhaler lasts for one month;
3. Percent of available salbutamol and inhaled corticosteroid prescriptions refilled by non-clinicians (ALB-non, STER-non);
4. Total number of months that each patient had data for the study;
5. Calculation of the actual STEP of asthma therapy for each patient based on the available medications that could have been filled over the months in the study. (The months of no corticosteroid inhaler, cromolyn, nedocromil, montelukast, or theophylline prescriptions were assigned as 'STEP 1');
6. Calculation of the ideal STEP for each patient if the asthma medications given were prescribed for every month in the study;
7. Number of prednisone prescriptions per year (PRED/yr), a proxy for poor control;
8. Ratio of STER/yr to ALB/yr for each patient prescribed inhaled corticosteroids (RATIO) with a value of 12 or greater representing 'ideal' prescribing and asthma control (i.e. a corticosteroid inhaler prescribed for every month of the year [12 in the numerator] and no more than one salbutamol inhaler per year [one in the denominator]); and
9. At the last asthma visit, the number of co-morbid diagnoses addressed.

Figure 1. Flow diagram of how patients were selected for the study



The author reviewed all 200 medical records to ensure that the charts that were included or excluded and the data abstracted was accurate.

Analysis

Regression analyses were performed as follows:

1. Logistic regression with any oral prednisone course (binary—yes, no) as the dependent variable (n=48); and

2. Analyses of covariance with the following dependent variables:

a. PRED/yr for only those patients prescribed oral prednisone (n=21);
b. ALB/yr (n=49);
c. STER/yr (n=37);
d. Difference between actual STEP and ideal STEP:
   i. all patients (n=48);
   ii. only those prescribed inhaled corticosteroids (n=36); and
e. RATIO (n=36).

The independent variables were those listed above under data abstracted.

If a dependent variable was not normally distributed, it was transformed to a more normally distributed one so the regression could be performed.

Stata 9.2 (College Station, TX, USA) was used for statistical analysis. Specific significance levels were obtained from http://www.quantitative-skills.com/sisa/calculations/signif.htm.

Results

Demographics

This was a largely female cohort with a plurality of Caucasians and a plurality of Medicaid-insured patients (Table 2).

Medication usage

Non-clinicians refilled 16.6% of the available corticosteroid inhalers and 35.3% of the available salbutamol inhalers. Almost four times as many available salbutamol inhalers were refilled by the non-clinicians as corticosteroid inhalers.

Table 2. Demographic variables

		Number	Percent
Gender	Male	10	20.4
	Female	39	79.6
Ethnicity	Caucasian	24	49.0
	African-American	11	22.4
	Hispanic	1	2.0
	Multiracial	1	2.0
	Unknown	12	24.5
Payer source	Private insurance	10	20.4
	Medicare	5	10.2
	Medicaid	22	44.9
	Self-pay	12	24.5

Table 3. Medication treatments for asthma

	All	Those not treated with inhaled corticosteroids	Those treated with inhaled corticosteroids
Number	49	12	37
PRED/yr	0.62	0.17	0.75
ALB/yr	11.8	10.8	12.0
STER/yr	5.4	–	7.2
RATIO	.64	–	0.85
Actual STEP avg.	2.2	1.1	2.5
Ideal STEP avg.	3.0	1.2	3.6

The number of oral prednisone courses per year was higher in patients treated with corticosteroid inhalers versus patients treated only with salbutamol inhalers (Table 3). The number of available salbutamol inhalers was comparable for both groups at almost one a month. The available corticosteroid inhalers per year was lower than ideal for patients prescribed inhaled corticosteroids at 7.2. For those patients prescribed corticosteroid inhalers, the RATIO was 0.85 and the average actual STEP (2.5) was less that the ideal STEP (3.6) by 1.1.

Severity of asthma

Table 4 shows the documented severity of asthma, and severities of asthma based on the

available medications prescribed, and the severities of asthma had medications been prescribed for all the months in the study.

Regression analyses

The results of the regression analyses are shown in Table 5. Any oral prednisone course for the whole group (n=48) was directly related to both clinical factors—severity of asthma and to actual STEP of asthma care—and to non-clinical factors—the percent of available salbutamol inhalers refilled by non-clinicians (ALB-non).

The number of available salbutamol inhalers written per year for the whole group (n=49) was directly related to the number of prednisone courses per year. For those patients prescribed oral prednisone (n=21), non-clinical factors were in play. Ethnicity and payer source were significant while months of data in the study was inversely related.

The difference between the actual STEP of asthma therapy and the ideal STEP for patients on inhaled corticosteroids (n=36) was directly related to the non-clinical factors of percent of available salbutamol inhalers refilled by non-clinicians. An inverse relationship was observed with the clinical factor of actual STEP of asthma therapy, where the more severe the asthma, the less difference between actual and ideal STEP of asthma therapy. When all patients are considered (n=48) the same two factors above were significant as well as an inverse relationship with those prescribed any inhaled corticosteroid. Payer source was now also significant.

The number of corticosteroid inhalers written per year for patients prescribed corticosteroid inhalers (n=37) was directly related to the clinical factor of actual STEP of asthma therapy and inversely related to the non-clinical factor of comorbid diagnoses. In this case, the more comorbid diagnoses, the less available corticosteroid inhalers were prescribed.

The RATIO for patients prescribed inhaled corticosteroids (n=36) was directly related to the actual STEP of asthma therapy and inversely related to the number of courses of PRED/year.

Discussion

For those patients prescribed inhaled corticosteroids, the study showed that the more comorbid conditions addressed during the last office visit in the study, the fewer available corticosteroid inhalers written. Ideally, having a dedicated visit for asthma management would help focus the clinician's attention on all the variables that need to be addressed. The establishment of an 'asthma clinic' is currently under development at our residency.

Since the percentage of available salbutamol inhalers refilled by non-clinicians is directly related to getting any oral prednisone medication for the

Table 4. Severity of asthma

	Documented asthma severity	Asthma severity based on asthma medications prescribed over all months in study	Asthma severity had asthma medications been prescribed for every month in study
Unknown	85.7		
Intermittent*		57.5	20.4
Mild persistent†	4.1	6.7	15.2
Moderate persistent‡	6.1	23.7	46.1
Severe persistent§	4.1	12.1	18.2

* Step 1
† Step 2
‡ Steps 3 and 4
§ Steps 5 and 6

Table 5. Regression analyses

Dependent variable	Any oral prednisone	PRED/yr*	ALB/yr†	STER/yr‡	Difference between actual and ideal STEP for all	Difference between actual and ideal STEP for those on inhaled steroids	RATIO§
Number	48	21	49	37	48	36	36
Actual STEP	.6714			.5611	-.5038	-.5234	.4437
ALB-non	.0238				.0081	.0075	
Months in study		.0225					
PRED/yr			.1338				-.2703
Co-morbid dx				-.1658			
Any inhaled steroids					-1.6722		
Ethnicity		significant					
Payer source		significant			significant		
R^2	0.20	0.71	0.15	0.70	0.62	0.45	0.30
P-value	0.0014	0.0008	0.0037	5.8×10^{-10}	2.0×10^{-8}	1.8×10^{-5}	0.0012

* inverse square root of PRED/yr

† square root ALB/yr

‡ natural logarithm of STER/yr

§ natural logarithm of RATIO

Dx diagnosis

entire group of patients, and directly related to patients not getting as many corticosteroid inhalers as they should, the recommendation to limit the number of salbutamol refills by non-clinicians to one inhaler, with a concomitant appointment with a clinician to adjust asthma medications, has been undertaken by our residency.

The concept of RATIO has been used in other studies—mostly with administrative databases with variable results. Some have found the higher the ratio, the more favourable the outcomes such as fewer hospital contacts,[11-13] but one did not show a decreased hospital admission rate.[14] The problem with using RATIO with aggregate data is that relationships may be found that may not occur at the individual level—such as linking prescription data with hospital admission data for asthma may select for more unstable asthmatics rather than the morbidity of all asthmatics. In addition, some studies use the number of 'items' prescribed in their analyses, where one item could be a prescription for one or 10 inhalers.[14] Without linkage to asthma diagnoses, those with chronic obstructive pulmonary disease will confound the associations since they would be expected to have a lower RATIO.

Our RATIO of 0.85 is greater than an order of magnitude below an 'ideal' ratio of 12 or greater for well-controlled asthma, defined as 12 corticosteroid inhalers per year to one salbutamol inhaler per year. Yet, in spite of that, the higher the RATIO, the fewer prednisone prescriptions per year were written, implying better asthma control. A study of low-income, minority children aged six months to 18 years of age showed that by adhering to the NAEPP asthma guidelines, RATIO increased by 75% and the number of courses of oral prednisone decreased by 32%.[13] Associated with this, the hospitalisation rate decreased 35%, asthma emergency room visits decreased by 27%, and outpatient visits decreased by 19%. RATIO could be a measure of quality asthma prescribing using individual patient-level data.

The fact that those whose asthma was more severe had a higher RATIO (and were prescribed less oral prednisone) says that clinicians tended to comply with the NAEPP guidelines when

the patient's asthma was worse. An additional factor is that adherence could be a function of disease severity, getting better as disease severity increases.[15] A retrospective chart review of patients with moderate to severe asthma in asthma specialty clinics showed that those with severe asthma were better controlled than those with moderate asthma.[8]

Limitations

The medication prescription rates were based on the number of medications that the patients could have filled based on the original prescription and all available refills. Since adherence to asthma medications is generally poor—about 40% to 78%—most patients probably did not fill all the refills available to them.[9,16]

In addition, patients who were prescribed both salbutamol and corticosteroid inhalers could have filled each type of medication at different rates. This action could have resulted in a higher or lower RATIO than what was calculated.

Patients could have gone to other health care facilities and obtained medications that would not be captured in our database.

The majority of our patients were women, so the results of this study may not be true for men.

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COMPETING INTERESTS
None declared.

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