Original Article

Change in Asthma Control Over Time: Predictors and Outcomes

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What is already known about this topic? Maintenance of asthma control over time is a clear goal of national asthma guidelines.

What does this article add to our knowledge? The degree of asthma control at one point in time is strongly related to the achievement or maintenance of control and to asthma exacerbations over time. Predictors of maintenance of control can be identified.

How does this study impact current management guidelines? Patients with uncontrolled asthma should receive intensive management and follow-up in an attempt to achieve well-controlled asthma over time.

BACKGROUND: Maintenance of asthma control over time is a clear goal of national asthma guidelines, but few studies have addressed the natural history of asthma control over time.
OBJECTIVE: To assess the impairment domain of asthma control over time in patients with persistent asthma and to determine predictors and consequences of controlled and uncontrolled asthma over time.
METHODS: Patients 18-56 years old with persistent asthma who completed baseline (November 2007) and follow-up asthma surveys (April, July, October 2008) were included in the study. The survey included the Asthma Control Test as well as questions regarding other patient and asthma characteristics. Health care utilization (pharmacy and exacerbations) for 2008 was obtained from administrative data.
RESULTS: The baseline and first follow-up surveys were completed by 1267 patients, and all 4 surveys were completed by 782 patients. Patients with well-controlled asthma at baseline were significantly more likely ($P < .0001$) to have well-controlled asthma over the following year (76.2%-80.4%) than patients with uncontrolled asthma at baseline (33.5%-36.9%). Patients whose asthma control improved over the first several months of follow-up experienced significantly ($P < .05$) fewer exacerbations over the subsequent year than patients with initially uncontrolled asthma who did not improve.
CONCLUSION: Degree of asthma control at one point in time is strongly related to the achievement or maintenance of control and to asthma exacerbations over time. Patients with uncontrolled asthma, especially very poorly controlled asthma, should receive intensive management and follow-up in an attempt to achieve well-controlled asthma over time. © 2013 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2014;2:59-64)

Key words: *Asthma; Asthma control; Maintenance of asthma control; Asthma Control Test; Asthma follow-up; Asthma exacerbations*

Achieving asthma control and maintaining it over time are major goals of asthma therapy.[1] Most research on asthma control has focused on achieving control at a point in time and the predictors and consequences of doing so. For example, studies have identified patient and management factors that predict asthma control at a single point in time,[2] and other studies have identified outcomes based on achieving asthma control at a point in time.[3-5] However, few data exist on factors that affect the maintenance of asthma control over time or that identify the relationship of asthma control over time to asthma outcomes. The purpose of this study was to assess the impairment domain of asthma control over time in a cohort of patients with persistent

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Abbreviations used
ACT- Asthma Control Test
BMI- Body mass index
CI- Confidence interval
ED- Emergency department
SABA- Short-acting β-agonist

asthma and to determine both predictors and consequences of controlled and uncontrolled asthma over time.

METHODS

Patients

This study was approved by the Kaiser Permanente Southern California Institutional Review Board. By using computerized Kaiser Permanente Southern California inpatient, outpatient, pharmacy, and membership records, we identified patients 18-56 years old, with persistent asthma in 2006 (study year 1) based on meeting one or more of the Healthcare Effectiveness Data and Information Set criteria: (1) 4 or more asthma medication dispensings, (2) one or more emergency department (ED) visits or hospitalizations with a principal diagnosis of asthma, or (3) 4 or more asthma outpatient visits, with 2 or more asthma medication dispensings. Only patients with continuous membership in Kaiser Permanente Southern California from 2006 to 2008 were included in the study.

Survey

In November of 2007, 13,933 eligible patients were mailed a survey. The survey included the Asthma Control Test (ACT), a validated tool for assessing the impairment domain of asthma control. Scores range from 5 to 25, with higher scores indicating better control. Scores of >19, 16-19, and <16 indicate Expert Panel Report 3 defined control categories of well-controlled, not well-controlled, and very poorly controlled asthma, respectively.[1]

The survey also included questions regarding (1) race/ethnicity, (2) educational attainment, (3) household income, (4) weight and height (for calculation of body mass index [BMI]), (5) smoking, (6) whether or not a specialist was the patient's "regular source of asthma care," and (7) a history of asthma exacerbations in the prior 12 months, including a hospitalization, unscheduled outpatient or ED visit, or oral corticosteroid course for asthma. The information from the survey was used only for research purposes and was not made available to the clinicians managing the patients.

Patients who completed the baseline surveys from November 2007 were sent follow-up surveys in April (spring), July (summer), and October (fall) of 2008, which also included the ACT. Only survey respondents who reported physician-diagnosed asthma on the baseline survey were included in the study.

Computerized data

The following additional information was captured from the computerized data: (1) sex, (2) age, (3) hospitalization with asthma coded (*International Classification of Diseases, Ninth Revision* 493.xx) as the primary diagnosis or the second diagnosis with another respiratory primary diagnosis, (4) ED visit with asthma coded (*International Classification of Diseases, Ninth Revision* 493.xx) as the primary diagnosis or the second diagnosis with another respiratory primary diagnosis, (5) oral corticosteroid dispensing within 7 days of an encounter coded as an asthma exacerbation or uncontrolled asthma, (6) short-acting β-agonist (SABA) canisters dispensed, and (7) asthma controller units (inhaled corticosteroid canisters with or without long-acting β-agonist, or a 30-day supply of leukotriene receptor antagonists) dispensed. Medical utilization for asthma (3-7 above) was assessed during 2008.

Data analysis

Baseline demographics, asthma severity, and asthma management as well as comorbidity characteristics were described in the cohort with both baseline and first follow-up surveys completed (n = 1267) and the cohort that completed all 4 surveys (n = 782). The relationships of baseline control (ACT > 19 vs ACT < 20 and ACT 16-19 vs ACT < 16) to (1) control status at each follow-up survey, and (2) the number of surveys with controlled asthma (ACT > 19) were evaluated by means of χ^2 analysis. Relationships between the change in control status from baseline to the first follow-up surveys and 2008 outcomes (asthma hospitalization or ED visit, oral corticosteroid dispensing linked to an asthma encounter, SABA canisters >6) were evaluated by univariate logistic regression. Patients with various combinations of well-controlled (ACT > 19), not well-controlled (ACT 16-19), and very poorly controlled (ACT < 16) asthma at baseline and first follow-up surveys were compared with patients with ACT > 19 on both surveys as the reference. Because this involved 8 different comparisons, a Bonferroni correction was applied such that only a P value < .00625 was considered significant for this analysis. Finally, the population average effect of each predictor of uncontrolled asthma (ACT ≤ 19) was estimated by multivariate Poisson regression with the generalized estimating equations method to handle the correlated nature of the response variable (4 measures of asthma control per patient). We specified an independent (unstructured) working correlation. Each estimate of a predictor was adjusted for season (time of each survey), patient demographic (age, sex, race/ethnicity, household income, educational level), asthma severity markers (exacerbations in the prior year or 3 months before the survey), management factors (baseline specialist care, controller dispensings), and comorbidities (smoking, BMI). Nominal 2-tailed statistical significance for all analyses except as noted above was set at $P < .05$. All analyses were conducted by using SAS EG version 4.3 (SAS Institute, Cary, NC).

RESULTS

Characteristics of study participants who completed at least the baseline and first follow-up surveys (n = 1267) and those who completed all 4 surveys (n = 782) are shown in Table I. The 2 cohorts were similar in demographic, socioeconomic, smoking, BMI, and utilization characteristics. The participants were approximately 75% women, 60% white, and 20% Hispanic. More than 80% of participants had more than a high school education, and more than 65% reported a household income higher than $50,000. A minority of patients (approximately 7%) were smokers, but a substantial proportion (>40%) were obese (Table I).

Relationship of baseline control to follow-up control

Patients with controlled asthma at baseline were much more likely to remain controlled over the following year than patients who were uncontrolled at baseline (Table II). Similarly, patients with not well-controlled asthma (ACT 16-19) at baseline were

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