Original Article

Predictive Properties of the Asthma Control Test and Its Component Questions for Severe Asthma Exacerbations

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What is already known about this topic? The Asthma Control Test (ACT) was initially validated against specialist assessment of control and is a widely used questionnaire for assessing impairment. However, its utility in predicting the risk of asthma exacerbation is not well studied.

What does this article add to our knowledge? This study assessed both the ACT and its component questions in a well-characterized, longitudinal cohort study. The ACT and assessments of short-acting beta-agonist use appeared to be comparable in predicting future exacerbations.

How does this study impact current management guidelines? Better tools are needed for determining the risk of severe asthma exacerbations. However, for the purposes of rapidly assessing risk clinically, inquiring about rescue medication use alone may be as good as the composite ACT score.

BACKGROUND: Current US guidelines recommend the Asthma Control Test (ACT) for assessing disease control and selecting treatment.

OBJECTIVE: The goal of this study was to prospectively assess the ACT and its component questions for their utility in predicting the risk of severe asthma exacerbations.

METHODS: Individuals were participants in the Study of Asthma Phenotypes and Pharmacogenomic Interactions by Race-Ethnicity, and those included in the current analysis had the following characteristics: age 18 years or more, physician-diagnosed asthma, and longitudinal care received at a large health system in southeastern Michigan. Study participants underwent a baseline evaluation, which included answering the ACT. A *severe asthma exacerbation* was defined as one requiring oral steroids, an emergency department visit, or inpatient admission. Receiver-operator characteristic curves were used to measure and compare the predictive utility of the ACT and its component questions for severe asthma exacerbations.

RESULTS: Of 1180 participants, 354 (30.0%) experienced a severe asthma exacerbation within 6 months of their baseline evaluation. When compared with the individual questions that composed the ACT, the composite score was significantly better at predicting severe exacerbations with 1 exception; the composite ACT score and the question assessing rescue medication use were not significantly different ($P = .580$). Pharmacy-based records of metered-dose inhaler short-acting beta-agonist use and asthma severity were also not significantly different from the composite ACT score.

CONCLUSIONS: Our study demonstrates that although the ACT is modestly predictive for exacerbations, the

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Abbreviations used
ACT- Asthma Control Test
AUC- Area under the curve
ICS- Inhaled corticosteroid
MDI- Metered-dose inhaler
NPV- Negative predictive value
OCS- Oral corticosteroid
PPV- Positive predictive value
SABA- Short-acting beta-agonist
SAPPHIRE- Study of Asthma Phenotypes and Pharmacogenomic Interactions by Race-Ethnicity

composite score may not be superior to assessing rescue medication use alone for predicting the risk of severe asthma exacerbations. **(J Allergy Clin Immunol Pract 2016;■:■-■)**

Key words: *Asthma Control Test; Asthma; Short-acting beta-agonist; Bronchodilator agents; Asthma exacerbation; Asthma rescue medication*

Asthma is a chronic disease of the lungs characterized by reversible inflammation of the airways.[1] Disease prevalence is rising, affecting 25.7 million people in the United States, and uncontrolled asthma is common, resulting in a high rate of unscheduled office visits, emergency department visits, and hospitalization each year.[2,3]

An ideal measure of asthma control must be able to assess both asthma impairment and risk.[1] The Asthma Control Test (ACT) is a commonly used self-assessment tool for monitoring asthma control and guiding therapy.[4,5] The ACT has been shown to overlap with other survey instruments in its assessment of control and asthma-related quality of life[6]; however, its utility as a predictive tool for asthma exacerbations is less certain. Moreover, because the ACT comprises 5 separate 5-point questions, these component questions may differ in their predictive utility for future asthma exacerbations. As a result, the ACT composite score may be less predictive of asthma exacerbations when compared with its component questions.

The Study of Asthma Phenotypes and Pharmacogenomic Interactions by Race-Ethnicity (SAPPHIRE) is a large, prospective, and multiethnic study of individuals with asthma.[7] All SAPPHIRE participants are asked to complete the ACT at the time of enrollment. By virtue of their health plan membership, SAPPHIRE patients also have detailed prospective information on diagnoses and medication use. Therefore, this is an ideal study population in which to assess longitudinal asthma outcomes after measuring asthma control. The goal of this study was to assess the ACT and its component questions for their ability to predict severe asthma exacerbations.

METHODS

Study setting and patients

This study was approved by the Institutional Review Board of Henry Ford Health System. Written informed consent was required for study enrollment. SAPPHIRE participants had the following characteristics: age 12 to 56 years, a previous clinical diagnosis of asthma, no previous recorded or reported history of chronic obstructive pulmonary disease and congestive heart disease, and regular outpatient care from a large health system in southeastern Michigan. The participants included in the current analysis also had health care and pharmaceutical coverage through a system-affiliated health provider; this meant that these study individuals had a record of health care utilization, which included insurance claims, encounter diagnoses, prescription fills, and visit types. We restricted the analytic set to adult individuals 18 years or older.

At the time of enrollment, participants had a baseline evaluation, which included anthropomorphic measurements, lung function testing, and completion of a study questionnaire. The latter included all the questions from the ACT (Optum Corp., Eden Prarie, Minn), which is a 5-question survey including questions about asthma's impact on daily functioning, frequency of shortness of breath symptoms, frequency of nocturnal asthma symptoms, frequency of rescue inhaler and nebulizer use, and an overall assessment of asthma control. Each question is scored on a 5-point Likert scale, with higher scores denoting better asthma control, such that the resulting composite ACT score ranges from 5 to 25.[4,5]

Exposure and outcome assessment

Short-acting beta-agonist (SABA) rescue medication use was measured using pharmacy claims data. National drug codes were recorded with each SABA medication dispensing, and this information was used to estimate the number of doses available for both metered-dose inhaler (MDI) and nebulized SABA prescription fills. We calculated separate measures for MDI and nebulizer usage because we have previously observed different predictive relationships between the use of these preparations and asthma exacerbations.[8] In short, we used the total number of doses dispensed (ie, the sum of doses in each dispensing) in the 6-month period preceding the baseline assessment to estimate "baseline" SABA MDI and nebulizer use. The baseline number of uses per day was estimated by dividing the total number of doses by 182.5 (ie, the number of days in half a year).

Prescription claims data and coded diagnoses from clinical visits were used to identify severe asthma exacerbations. A severe asthma exacerbation was defined as the need for burst oral steroids, an emergency department visit for asthma, or an asthma-related hospitalization.

Adapting a method described by Allen-Ramey et al,[9] we also created a baseline asthma severity measure based on medication fills in the year before the initial assessment. The most severe group (severity = 4) had either 3 or more oral corticosteroid (OCS) fills or 2 OCS fills and more than 6 SABA fills. The moderate to severe group (severity = 3) had either 2 OCS fills or more than 6 SABA fills or 1 OCS fill and 4 or more SABA fills. The low severity group (severity = 1) had no OCS fills and 1 or less SABA fill. All other combinations of SABA and OCS fills made up the low to moderate severity group (severity = 2).

Statistical analysis

We created receiver-operating characteristic curves for the ACT composite score and each of its component questions for their sensitivity and specificity for a severe asthma exacerbation within the 3 and 6 months following assessment. For each ACT question and the composite score, we calculated areas under the curve (AUCs), which were used to compare the predictive utility for each measure. The primary analysis compared the composite ACT score with each of the ACT component questions for predicting severe asthma