Development of the Asthma Control Test: A survey for assessing asthma control

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Background: Asthma guidelines indicate that the goal of treatment should be optimum asthma control. In a busy clinic practice with limited time and resources, there is need for a simple method for assessing asthma control with or without lung function testing.
Objectives: The objective of this article was to describe the development of the Asthma Control Test (ACT), a patient-based tool for identifying patients with poorly controlled asthma.
Methods: A 22-item survey was administered to 471 patients with asthma in the offices of asthma specialists. The specialist's rating of asthma control after spirometry was also collected. Stepwise regression methods were used to select a subset of items that showed the greatest discriminant validity in relation to the specialist's rating of asthma control. Internal consistency reliability was computed, and discriminant validity tests were conducted for ACT scale scores. The performance of ACT was investigated by using logistic regression methods and receiver operating characteristic analyses.
Results: Five items were selected from regression analyses. The internal consistency reliability of the 5-item ACT scale was 0.84. ACT scale scores discriminated between groups of patients differing in the specialist's rating of asthma control ($F = 34.5$, $P < .00001$), the need for change in patient's therapy ($F = 40.3$, $P < .00001$), and percent predicted FEV_1 ($F = 4.3$, $P = .0052$). As a screening tool, the overall agreement between ACT and the specialist's rating ranged from 71% to 78% depending on the cut points used, and the area under the receiver operating characteristic curve was 0.77.
Conclusion: Results reinforce the usefulness of a brief, easy to administer, patient-based index of asthma control. (J Allergy Clin Immunol 2004;113:59-65.)

Key words: *Asthma, questionnaires, outcomes research, patient care management, screening*

Abbreviations used
ACQ: Asthma Control Questionnaire
ACT: Asthma Control Test
ATAQ: Asthma Therapy Assessment Questionnaire
NHLBI: National Heart, Lung and Blood Institute
ROC: Receiver operating characteristic

Asthma affects more than 5% of the world's population, and indicators suggest that its prevalence continues to rise, particularly among children.[1-4] In spite of recent advances in the detection and treatment of the condition, asthma remains the cause of significant morbidity and economic burden. In the United States alone, asthma accounts for 2 million emergency visits a year[3] and, with approximately 500,000 hospitalizations annually, is the third leading cause of preventable hospitalization.[5]

During the last decade an improved understanding of the pathophysiology underlying asthma and the emergence of medications to prevent acute exacerbations more effectively have led clinicians to shift their focus from managing acute attacks to achieving asthma control.[2,3] Current asthma treatment guidelines highlight this change in focus and underscore the multidimensional nature of asthma control. According to the National Heart, Lung and Blood Institute (NHLBI) guidelines, effective asthma management requires the development of an individualized treatment plan aimed at minimizing symptoms and use of quick-relief β_2-agonists, preventing limitations in work and other physical activity, and preventing the occurrence of acute attacks and a need for emergency treatment and hospitalization.[2]

Despite the existence of treatment guidelines, however, a recent study suggests that the asthma symptom burden might be significantly higher than previously estimated.[6] As a result, many patients with asthma continue to be undertreated and are at risk for acute exacerbations resulting in missed work or school, increased use of expensive health care services, and reduced quality of life.[6] The fact that the level of asthma control is often overestimated by both patients and physicians indicates that asthma treatment guidelines alone are not enough to ensure the proper assessment of asthma control. This deficiency in the assessment of asthma control points to

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TABLE I. Abbreviated text for 22 survey items used in the development of ACT

Question	Abbreviated text	Responses*
Q1	Asthma limit your usual activities and enjoyment of everyday life	A
Q2	Felt fed up or frustrated because of your asthma	B
Q3	**Asthma keep you from getting as much done at work or home**	**B†**
Q4	Asthma restrict you in performing your usual daily activities	C
Q5	Asthma keep you from socializing	D
Q6	**Rate your asthma control**	**E†**
Q7	Had any asthma symptoms	F
Q8a	How often have you had wheezing	F
Q8b	How often have you had tightness or pain in your chest	F
Q8c	**How often have you had shortness of breath**	**F†**
Q8d	How often have you had coughing	F
Q9	**Asthma symptoms wake you up at night or earlier than usual**	**G†**
Q10	Awaken at your usual time in morning with asthma symptoms	G
Q11	How often did you have an asthma episode or attack	G
Q12	How many days did asthma limit your daily activities	H
Q13	How many days did asthma keep you at home for more than half a day	H
Q14	Asthma limit your ability to exercise	D
Q15	Missed any time from work or school because of asthma	H
Q16	**Used your rescue inhaler or nebulizer medication**	**I†**
Q17	Stay in hospital overnight because of asthma	H
Q18	Visit an urgent care facility or emergency room because of asthma	H
Q19	Unscheduled visit to primary care physician because of asthma	H

Boldfaced items were selected for ACT.
*Key to response options:
A: 1, not at all; 2, a little; 3, moderately; 4, quite a lot; 5, extremely.
B: 1, none of the time; 2, a little of the time; 3, some of the time; 4, most of the time; 5, all the time.
C: 1, not at all; 2, very little; 3, somewhat; 4, quite a lot; 5, could not do activities.
D: 1, never; 2, rarely; 3, sometimes; 4, often; 5, quite often.
E: 1, not controlled at all; 2, poorly controlled; 3, somewhat controlled; 4, well controlled; 5, completely controlled.
F: 1, not at all; 2, once or twice a week; 3, 3 to 6 times a week; 4, once a day; 5, more than once a day.
G: 1, not at all; 2, once or twice; 3, once a week; 4, 2 to 3 nights a week; 5, 4 or more nights a week.
H: Report of the number of days in last month.
I: 1, not at all; 2, once a week or less; 3, a few times a week; 4, 1 or 2 times per day; 5, 3 or more times a day.
†Cut points for sum of counts scoring option determined based on face validity:
Q3, Q8c, Q9, Q16: count = 1 for controlled response options 1, 2; count = 0 for poorly controlled response options 3, 4, 5.
Q6: count = 1 for controlled response options 4, 5; count = 0 for poorly controlled response options 1, 2, 3.

the need for a simple method for quantifying asthma control by both patients and physicians. Although several investigators have developed tools that quantify asthma control, either the performance of these tools has not been evaluated against a criterion measure of asthma control[7,8] or they are difficult to score and require measures that are not currently integrated into clinical practice.[9] This study describes the development of a brief patient-based assessment tool to assess asthma control with or without the use of lung function testing. In developing the Asthma Control Test (ACT), the investigators sought to (1) produce a questionnaire that reflected the multidimensional nature of asthma control and (2) demonstrate its performance against criterion measures of asthma control.

METHODS

Working groups and survey development

A working group composed of primary care clinicians (n = 4) and of leading asthma specialists (n = 7) was convened to advise on the development of a tool for assessing control. The working group participants represented a range of geographic regions in the United States. The working group helped to specify the components of asthma control that should be assessed by the survey and participated in defining a criterion measure of asthma control that would be used in evaluating the survey's performance. The specialists also helped guide development of the specific survey questions and participated in designing and implementing the clinical validation study. The final survey instrument fielded in the study consisted of 22 items (Table I) that reflected the multidimensional nature of asthma control and were consistent with asthma guidelines. Each survey item asked the respondent to consider the last 4 weeks.

Data collection

Patients receiving care from 1 of 6 asthma specialty groups were recruited to participate in the study. Institutional Review Boards for each site approved the study, and all patients and guardians signed a written informed consent. Each of the participating practices included 1 of the asthma specialists involved in the study's working group. It was believed that on-site availability of a working group member would help ensure standardized application of the study protocol including the process used to arrive at the specialist's rating of control. Patients older than 12 years of age who had been diagnosed with asthma and who were literate in English were eligible for participation unless they had other respiratory conditions or were participating in other clinical studies. Data were collected during a 4-week time period.

Participants completed the survey during a routine, previously scheduled physician office visit. After each patient completed a survey, office staff recorded pre-bronchodilator measurements of FEV_1, and the asthma specialist, who was blinded to each subject's survey responses, interviewed the patient. During the visit the level of asthma control for each subject was rated by the asthma specialist on a 5-point scale ranging from "not controlled at all" to "completely controlled." This rating of asthma control was based on how well the goals of asthma therapy were being met, as outlined in the NHLBI guidelines[2] and as determined from the history, physical examination, and FEV_1 (percent predicted and relation to prior maxima). The rating of asthma control was applied across all asthma severity levels.

Item selection

Stepwise logistic regression methods were used to identify the survey items with the greatest validity in discriminating between patients who differed in the specialist's rating of asthma control. All 22 items were entered as independent variables in the stepwise regression model. In addition, because FEV_1 values and the specialist's rating of control differed significantly across sites, the analyses controlled for site. The dependent variable was the specialist's rating of asthma control. Because the distribution of the specialist's rating of control was skewed toward better control, we derived a dichotomous variable for the analysis. Patients were categorized as not controlled (and assigned a value of 1) if the specialist had rated the patient as not controlled at all, poorly controlled, or somewhat controlled. Patients were categorized as controlled (and assigned a value of 0) if the specialist had rated the patient as well controlled or completely controlled. By assigning patients rated as somewhat controlled to the not controlled category, we improved the distribution of the dependent variable and ensured that the controlled category included only patients whose asthma was truly in control.

Items were entered into the model in a forward stepwise fashion. The criterion for entry was significant discrimination at a statistical significance level of *P* less than .05. Items meeting the entry criteria were selected for inclusion in the final short-form ACT survey.

Because of concerns over classifying patients as not controlled with a specialist rating of somewhat controlled, we conducted a sensitivity analysis by using ordered logistic regression methods to determine which of the 22 survey items would be selected under a model that used a dependent variable with 3 levels of asthma control. Patients rated as not controlled at all and poorly controlled were assigned to the first level, patients rated as somewhat controlled were assigned to the second level, and patients rated as well controlled or completely controlled were assigned to the third level. The criterion for entry into this model was significant discrimination at a statistical significance level of *P* less than .05.

Reliability

Once the final subset of items was identified from the stepwise regression analyses, reliability was assessed by using internal consistency reliability methods and Cronbach's alpha.

Empirical validation

With the final subset of items selected, the ACT scale was scored by using 2 scoring options (explained below) with higher scores indicative of better control. First, Pearson correlation coefficients were calculated between ACT scores, the specialist rating of control, and FEV_1. Second, tests of validity were designed to address issues involved in the intended use of the ACT survey and conditions that might affect interpretations. For example, ACT is intended to assess the patient's level of asthma control and should discriminate between groups of patients who differ in asthma control according to proven clinical measures. This standard method of construct validation follows the logic of known groups validity.[10] For these tests patients were categorized into groups known to differ in asthma control derived from 3 criterion measures. The first criterion measure consisted of the specialist's rating of control. Five groups of patients differing in level of asthma control were formed on the basis of the specific rating. The second criterion measure consisted of percent predicted FEV_1 values. Patients were categorized into 4 groups according to their FEV_1 values. Group 1 consisted of patients with FEV_1 values ranging from 30% to 59%, group 2 ranged from 60% to 79%, group 3 ranged from 80% to 100%, and group 4 ranged from 101% to 140%. The third criterion measure consisted of whether the specialist changed the patient's therapy as a result of the visit. Patients were categorized into 3 groups: (1) stepped down therapy, (2) no change in therapy, and (3) stepped up therapy. Analysis of variance methods were used to evaluate the ability of ACT scale scores to discriminate between the groups derived from these 3 criterion measures. We hypothesized that the groups of patients classified as in "better" control according to the specialist's rating and as determined by percent predicted FEV_1 would score higher on ACT than the groups of patients classified as having little or no control. Similarly, we hypothesized that patients categorized as stepped down therapy group or no change in therapy group would score higher on ACT than patients categorized as stepped up therapy group.

Screening accuracy

The screening accuracy of ACT as a tool to identify patients with asthma control problems was evaluated for 2 scoring options. The first scoring option (sum score) consisted of summing responses to the selected items to produce a continuous sum score in which a higher score indicated better asthma control (range, 5 to 25). The second scoring option (sum of counts) consisted of deriving a dichotomous variable with values of 0 (indicating poor control) and 1 (indicating control) for each ACT item (Table I) and summing across items to produce a score that ranged from 0 (no control) to 5 (complete control).

Receiver operating characteristic (ROC) analyses were conducted to evaluate the ACT in screening for subjects with poorly controlled asthma and to compare and contrast the performance of the 2 scoring options. The criterion measure for these analyses was the specialist's rating of asthma control. Patients were classified as poorly controlled (value of 0) if the specialist's rating was not controlled at all or poorly controlled or somewhat controlled. The ROC curve displays on a plane the entire set of achievable pairs of sensitivity and specificity statistics as the cut point score is varied along the entire range of scale scores and provides a statistical basis for comparing different scoring procedures for a single instrument.[11] To compare the areas under the ROC curves for the 2 scoring options of ACT, standard errors of the estimated ROC areas for each scoring option were calculated,[12,13] and significance tests were conducted on the differences between ROC areas.[12] In addition to the ROC analyses, odds ratios, sensitivity and specificity statistics, positive and negative predictive values, and the percent correctly classified were estimated at each scoring level or "cut point" for both scoring options of ACT.

RESULTS

Sample

Four hundred seventy-one patients completed the survey. Of the 471 respondents, 407 (86.4%) completed all 22 survey items. The average age of respondents was 45.2 years (SD, 18.5) with a range of 12 to 94 years.

TABLE II. Summary of forward selection of ACT items in logistic regression analyses

Item	Description	Number entered	Odds ratio (confidence limits)	Chi-square	*P* value
Q8C	Shortness of breath	1	1.25 (1.02, 1.61)	54.4273	0.0000
Q6	Patient rating of control	2	0.68 (0.48, 0.95)	14.1044	0.0002
Q16	Use of rescue medication	3	1.30 (1.02, 1.66)	7.1375	–0.0075
Q3	Asthma keeps you from getting much done at work/school	4	1.66 (1.15, 2.40)	5.8535	0.0155
Q9	Asthma symptoms wake you up	5	1.22 (1.04, 1.56)	4.1618	–0.0413

The model controlled for site.

TABLE III. Comparison of mean (SDs) ACT scores across groups differing in asthma control

	Specialist rating of control						
	Not controlled at all (n = 2)	Poorly controlled (n = 28)	Somewhat controlled (n = 103)	Well controlled (n = 224)	Completely controlled (n = 79)	F	*P* value
ACT sum scoring	7.5 (0.7)	15.5 (4.4)	16.9 (4.7)	20.8 (3.4)	21.5 (3.9)	34.5	.0000
ACT sum of counts	0 (0.0)	1.8 (1.5)	2.6 (1.7)	3.9 (1.3)	4.2 (1.3)	33.7	.0000
	Change patient's therapy						
	Stepped down (n = 52)	No change (n = 269)	Stepped up (n = 115)			F	*P* value
ACT sum scoring	20.6 (4.1)	20.8 (3.6)	16.6 (5.0)	—	—	40.4	.0000
ACT sum of counts	3.9 (1.4)	3.9 (1.4)	2.4 (1.7)	—	—	38.9	.0000
	% Predicted FEV_1 values						
	30% to 59% (n = 48)	60% to 79% (n = 113)	80% to 100% (n = 192)	101% to 140% (n = 87)		F	*P* value
ACT sum scoring	18.3 (4.7)	19.0 (4.8)	19.9 (4.4)	20.9 (3.5)	—	4.3	.0052
ACT sum of counts	3.1 (1.7)	3.3 (1.7)	3.5 (1.6)	4.0 (1.3)	—	3.8	.0099

Approximately 14% of the sample was age 65 years or older, and 12% were younger than 20 years of age. The majority of the sample had asthma that was well controlled (52.2%) or completely controlled (18.1%) according to the specialist's rating of asthma control. The mean percent predicted FEV_1 value of the sample was 84.9 (range, 30 to 140), and 64% of the sample had values greater than 80%.

Item selection

Results of the forward stepwise logistic regression analyses showed 5 items meeting the model selection entry criteria (Table II). The shortness of breath item was the first item selected in the model, followed by the patient's rating of asthma control, use of rescue medication, role limitations due to asthma, and nocturnal asthma symptoms. Results of the sensitivity analyses that used the 3-level dependent variable of asthma control confirmed the selection of 4 of 5 of the items (data not shown). The one item that was not selected in the sensitivity analyses was the shortness of breath item. This item was thought to be too important to exclude from the final item set.

Reliability

The internal consistency reliability of the 5-item ACT survey was 0.84 in the total sample (n = 436). Among the 133 patients categorized as not controlled according to the specialist's rating of control (not controlled at all, poorly controlled, or somewhat controlled) the internal consistency reliability of the 5-item ACT survey was 0.83. The internal consistency reliability of the 5-item ACT survey among the 303 patients categorized as controlled (well controlled or completely controlled) was 0.79.

Empirical validation

Moderate to low correlations between the ACT, FEV_1, and the specialist's rating of control were observed. The highest correlation coefficient was observed between the specialist's rating and ACT scores ($r = 0.45$, $P = .0001$). The correlation between the specialist's rating and FEV_1 values was moderate ($r = 0.37$, $P = .0001$). The correlation between FEV_1 values and ACT scores was low ($r = 0.19$, $P = .0001$).

Table III presents the results from the tests of the empirical validity of ACT in discriminating among groups known to differ in asthma control and change in therapy. As hypothesized, mean ACT scores for both scoring options differed significantly across the groups of patients who differed in level of asthma control defined by the specialist's rating of control and by percent predicted FEV_1 levels. Also, mean ACT scores were significantly lower in patients whose therapy was stepped down or not changed.

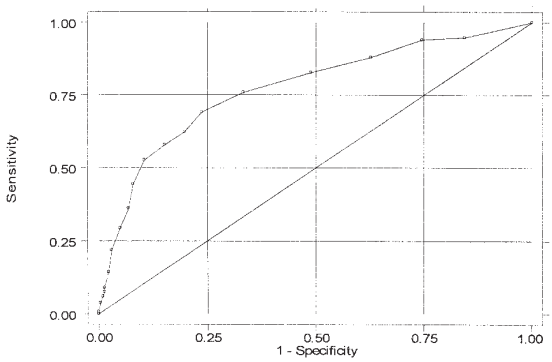

FIG 1. Area under the ROC curve for sum scoring option (range 5 to 25). Area under ROC curve = 0.7740.

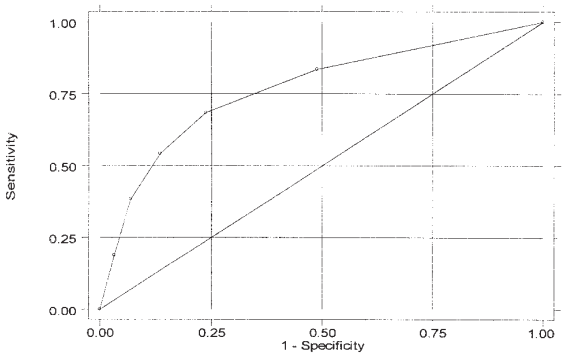

FIG 2. Area under the ROC curve for sum of counts scoring option (range 0 to 5). Area under ROC curve = 0.7664.

Screening accuracy

atively higher sensitivity and lower specificity, meaning that at higher cut point levels, ACT performed better at

TABLE IV. Summary of the performance of simple sum scoring at various cut points in screening for uncontrolled asthma (N = 436)*

Cut point score	Odds ratio	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)	% Correctly classified	Area under ROC
≤10	7.41	9.0	98.7	75.0	71.2	71.3	0.539
≤11	7.04	14.3	97.7	73.1	72.2	72.3	0.560
≤12	9.11	21.8	97.0	76.3	73.9	74.1	0.594
≤13	7.96	29.3	95.1	72.2	75.4	75.0	0.622
≤14	7.58	36.1	93.1	69.6	76.8	75.7	0.646
≤15	9.27	44.4	92.1	71.1	79.0	77.5	0.682
≤16	9.41	52.6	89.4	68.6	81.1	78.2	0.710
≤17	7.68	57.9	84.8	62.6	82.1	76.6	0.714
≤18	6.72	62.4	80.2	58.0	82.9	74.8	0.713
≤19	7.20	69.2	76.2	56.1	84.9	74.1	0.727
≤20	6.31	75.9	66.7	50.0	86.3	69.5	0.713
≤21	5.01	82.7	51.2	42.6	87.1	60.7	0.669
≤22	4.35	87.9	37.3	38.1	87.6	52.8	0.626
≤23	5.32	94.0	25.4	35.6	90.6	46.3	0.597
≤24	3.31	94.7	15.1	33.0	87.0	39.6	0.551
Continuous	0.78	44.4	92.01	71.1	79.0	77.5	0.774

*Specialist's rating of not controlled at all, poorly controlled, or somewhat controlled.

Figs 1 and 2 present the ROC curves associated with the sum score scoring option and the sum of counts scoring option. Specifically, the areas under the ROC curves are 0.774 and 0.766, respectively. Comparisons of the areas under the ROC curves showed no statistically significant differences (P = .525) between the scoring options, indicating that the 2 scoring methods provided the same screening information regarding asthma control.

Table IV summarizes the performance of the sum scoring option in screening for patients with asthma control problems. Each score level represents a cut point that separates patients who are in control and patients who are not in control. Statistics are presented beginning with score level 10. Score levels below 10 are not presented because they yielded poor classification statistics. As shown in Table IV, lower cut point scores were associated with lower sensitivity and higher specificity. Conversely, higher cut point scores were associated with relatively higher sensitivity and lower specificity, meaning that at higher cut point levels, ACT performed better at detecting uncontrolled cases (higher sensitivity) but also identified more controlled cases as uncontrolled (low specificity). The performance of the sum of counts scoring option (data not shown) followed a similar trend, with higher score levels demonstrating higher sensitivity but lower specificity. A cut point of 19 demonstrated the highest area under the ROC curve, and overall agreement between the ACT and specialist's rating ranged from 71.3% to 78.2% at cut points between 10 and 19.

DISCUSSION

The 5 items empirically selected for the ACT survey parallel the dimensions of asthma control that underlie current asthma management guidelines—asthma symptoms, use of rescue medications, and the impact of asthma on everyday functioning—and support the premise that asthma control is a multidimensional construct. In this study, scores com-

puted from ACT were shown to be reliable and valid, and the test as a whole shows promising ability to screen for patients with poorly controlled asthma.

Two of the items in ACT merit special comment. One asks patients to assess the impact of asthma on everyday functioning at school or work (Q3). The strong and independent performance of this item in discriminating between patients who do and do not have controlled asthma lends support to the suggestion that functional impact can be routinely assessed when evaluating patients.[14] As these authors noted, clinicians too often limit their assessment of patients to consideration of physiologic markers and symptoms.[14] The performance of the functional impact item highlights the fact that important information might be missed if assessment is not broadened to include factors such as the impact of disease on functioning and role performance.

The other ACT item of note is one that obtains the patient's self-rating of asthma control (Q6). As discussed earlier, a recent study[6] suggested that many patients tend to overestimate their level of asthma control. In contrast, we found that patients' and specialists' ratings of asthma control demonstrated a high degree of concordance. Perhaps an element of selection bias is partially responsible for our findings. All subjects in our study were drawn from a population of patients treated by asthma specialists. Arguably, patients treated by specialists might be better educated about asthma and asthma management than patients treated in primary care settings, and, therefore, these patients might be more likely to assess their level of control accurately than patients treated in a primary care setting. We plan to examine this issue as part of an ongoing longitudinal study in which we will evaluate the level of concordance between physician and patient ratings of asthma control in general practice settings. It is worth noting that in some instances responses to this item might be particularly helpful to clinicians by serving as a "red flag" that identifies patients who would benefit from further education about their disease. If, for example, a patient rates his or her asthma as controlled but responses to the other ACT items indicate otherwise, additional patient education regarding asthma control and self-monitoring might be warranted.

The specialist's rating of control was based on the treatment goals of the NHLBI guidelines. However, no accepted system of defining control in relation to these goals has been articulated. In the absence of specific criteria, we believed that the best approach was to use the summary judgment of experienced specialists, who were aware of both the NHLBI goals of therapy as well as all relevant aspects of their patient's clinical status.

The content of the ACT is similar to other previously developed tools that quantify asthma control. For example, the ACT, Asthma Control Questionnaire (ACQ), and Asthma Therapy Assessment Questionnaire (ATAQ) all contain questions regarding nocturnal symptoms, rescue medication use, and role limitations. However, the distinguishing feature of this study was use of a criterion measure of asthma control. This study feature allowed us to evaluate the concordance between a patient-based measure of asthma control and a measure of asthma control based on the ratings of asthma specialists. As this study demonstrated, the patient can be an invaluable source of information for monitoring asthma control. Furthermore, the criterion measure of asthma control proved useful in determining clinically meaningful cut points for interpreting ACT scores (Table IV). The ACT provides a more simplified assessment of control by not requiring FEV_1 (because many patients are managed in settings in which FEV_1 is not available) and by providing a meaningful and easy to use scoring method, which is simpler than the ACQ, yet more comprehensive than the ATAQ for evaluating the range of asthma control.

In this study we observed a stronger correlation between the ACT scores and the specialist's rating of control than between FEV_1 and the specialist's rating of control, which was not unexpected and is consistent with the findings observed in other studies.[7,9,15,16] These results confirm that asthma control cannot be inferred from the clinical measure of airway function alone.

Another distinguishing feature of ACT concerns scoring. Our work to evaluate scoring options focused on identifying the method that performed best in screening for patients not in control and that could be easily applied in any setting. Although the simple sum scoring method produces many more scale levels and thus greater measurement precision than the sum of counts option, which should enhance its performance in tracking outcomes over time, the sum of counts method might be more practical in a busy practice by reducing the time necessary to compute and to interpret an ACT score. For example, calculation of scores with the sum of counts method could be enhanced through simple survey formatting in which the color coding is used to distinguish the item responses that indicate a control problem on each question. The clinician would then simply add up the number of times a patient's response to an item was in the color indicative of a control problem. This study showed that the tradeoff in using the sum of counts method was minimal in screening for patients not in control. Whether the sum of counts method represents a significant tradeoff in monitoring outcomes over time is currently being evaluated in ongoing longitudinal studies.

Recognizing that the ACT survey might be used for many different purposes, we have avoided recommending one particular score level as a cut point that should be used in all cases. Rather, we encourage health care providers to select the cut point that makes sense for a particular application. For example, an investigator who is interested in identifying patients with uncontrolled asthma for inclusion in an asthma treatment study might opt to use a cut point score that has a high degree of specificity, thus minimizing the inclusion of false-positive cases. Conversely, clinicians involved in a disease management program who plan to use ACT as an initial screening tool might decide to choose a cut point associated with a high degree of sensitivity. Such a cut point would ensure that most patients whose asthma is not in

control are identified for inclusion in the program. More resource intensive screening (to identify false positives) could then be applied only to those who were selected through the initial screening with ACT. It is interesting to note that ACT scores explained significantly more variance in the specialist's rating of control than FEV_1 alone (data not shown), but that ACT scores and FEV_1 combined explained more variance in the specialist's rating of control than either alone. Thus, although ACT performs well in the absence of FEV_1, the best measure of control would be a combination of both ACT and FEV_1.

As the focus of asthma management has shifted from managing acute attacks to achieving asthma control, the need for a supplemental measure that can reliably identify patients whose asthma is not in control has become apparent. The ACT survey, a clinically validated measure of asthma control that is simple to administer, should be useful to clinicians who are interested in assessing asthma control in patients within their practice and to investigators seeking to assess the level of asthma control within a population, with or without the use of lung function testing. We anticipate that tools such as the ACT survey will play an important role in ongoing and future efforts to evaluate and to refine asthma treatment guidelines.

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