

The Childhood Asthma Control Test*: Retrospective determination and clinical validation of a cut point to identify children with very poorly controlled asthma

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Background: The Childhood Asthma Control Test (C-ACT) has demonstrated validity in classifying children aged 4 to 11 years as having either “well-controlled” or “not well-controlled” asthma. However, new asthma management guidelines distinguish 3 levels of asthma control.

Objective: We sought to determine a second cut point on the C-ACT to identify children with “very poorly controlled” asthma. **Methods:** Binomial logistic regression was performed on data from 671 children. The specialist’s rating of control was the criterion measure. Specialists’ severity ratings, specialists’ assessment of therapy, and FEV₁ percent predicted were used to assess the clinical validity of the cut point.

Results: A cut point of 12 was selected because it correctly classified the highest percentage of participants (66.3%) as having “very poorly controlled” (vs “not well controlled”) asthma and demonstrated high specificity (89.8%) and moderate positive predictive value (69.1%). Children scoring 12 or less versus 13 to 19 had lower mean FEV₁ percent predicted (79.8% vs 92.6%, $P = .0002$) and were more frequently stepped up in therapy (72.9% vs 53.6%, $P = .0131$) and rated as having severe asthma (13.6% vs 4.5%, $P = .0005$). One month later, significant differences in C-ACT scores and lung function between these 2 groups persisted. The mean C-ACT score of

participants classified as “very poorly controlled” was significantly lower than that of participants classified as “not well-controlled” (17.2 vs 20.3, respectively; $P = .0001$).

Conclusion: A second cut point of 12 or less on the C-ACT identifies children with the lowest level of control, who are at risk for poorer outcomes, and is conceptually consistent with the classification of “very poorly controlled” asthma adopted by asthma management guidelines. (*J Allergy Clin Immunol* 2010;126:267-73.)

Key words: Asthma, pediatric, control, symptom assessment, questionnaire, disease management

The Expert Panel Report, third version (EPR3), of the national asthma management guidelines developed by the National Heart, Lung, and Blood Institute established a central role for asthma control assessment in monitoring and managing asthma.¹ Asthma control, as defined at 3 levels, (well controlled, not well controlled, or very poorly controlled) incorporates multidimensional measures of impairment and risk and guides decisions for asthma management, including adjusting therapy (ie, stepping up or stepping down treatment). The Global Initiative for Asthma² similarly describes 3 levels of asthma control (controlled, partly controlled,

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Abbreviations used

ACT: Asthma Control Test
 C-ACT: Childhood Asthma Control Test
 EPR3: Expert Panel Report, third version
 ROC: Receiver operating characteristic

and uncontrolled). National and international guidelines endorse validated questionnaires developed for assessing asthma control. Such questionnaires, combined with other parameters, including clinical assessment and spirometry, have the potential to reflect the complexity of asthma control. They can provide an optimal combination of standardized reliable assessments with ease of implementation in clinical practice and research.

For the Asthma Control Test (ACT), a questionnaire to assess asthma control in adults and adolescents 12 years of age and older, 2 cut points have been identified and incorporated into the EPR3 asthma guidelines.³ Most research with the ACT has focused on the first cut point of 19 and classifies subjects as either not well controlled (scores ≤ 19) or well controlled.¹ A second cut point (ie, a score of 15) was also established by the developers of the ACT to identify a group of patients with the lowest level of control. These 2 cut points, scores of 19 and 15, separate patients into 3 categories of asthma control. The EPR3 aligns these categories with their division of asthma control by describing them as “well controlled,” “not well controlled,” and “very poorly controlled.” When ACT scores are used to classify patients into one of 3 control levels, the term “not well controlled” is used for those with ACT scores between 16 and 19, and those with scores of 15 or less are classified as “very poorly controlled.”

The Childhood Asthma Control Test (C-ACT), a 7-item validated questionnaire capturing the frequency of asthma symptoms and their effect on daily function in children 4 to 11 years of age, uses a single cut point of a score of 19 to identify children whose asthma is not well controlled (see Fig E1 in this article's Online Repository at www.jacionline.org).⁴ Establishing a second cut point for the C-ACT would provide scores to represent the 3 levels of asthma control used in the guidelines. The purpose of the current investigation was to determine through statistical and clinical validation approaches whether a second cut point for the C-ACT could distinguish children with very poorly controlled asthma from those whose asthma is not well controlled. Because children with very poorly controlled asthma are at high risk of debilitating outcomes, this cut point would also be of benefit for clinicians and disease management programs by reducing use of resources and minimizing associated costs.

METHODS**Study design**

The C-ACT validation studies completed by children aged 4 to 11 years and their parents were cross-sectional ($n = 343$)⁴ and longitudinal ($n = 338$).⁵ Both studies used similar assessments: each child participant had a clinician-confirmed diagnosis of asthma, as defined by the American Thoracic Society, with symptomatic improvement in response to use of short-acting β_2 -

agonist bronchodilator, a history of documented reversible airway disease demonstrated by an increase of 12% or greater in FEV₁ over baseline within 30 minutes of albuterol inhalation or after prednisone burst, or both. Participation in the 2 studies included a visit at baseline to an asthma specialist; the longitudinal study also included a second visit at approximately 1 month (4-6 weeks) later. Children otherwise received their usual care. Institutional review board approval was granted by local committees, and informed consent was obtained from parents/caregivers (an assent form was also obtained from the children 7 years of age and older).

Study assessments

Spirometric data were collected before and after administration of a short-acting β_2 -agonist bronchodilator for children who were able to complete the test at baseline. In addition, specialist-assessed measures were gathered at baseline for each child, including ratings of asthma symptoms, use of albuterol, need for therapy change, medication history, asthma severity, and global assessment of asthma control. Specialists classified asthma severity as either “mild,” “moderate,” or “severe.” The specialist's global assessment rating of asthma control was made on a 5-point scale (“not controlled at all,” “poorly controlled,” “somewhat controlled,” “well controlled,” and “completely controlled”).

The children and their parents were instructed to provide sociodemographic information and to complete health assessment questionnaires and the C-ACT as accurately as possible. The 4 child-completed and 3 caregiver-completed C-ACT items capture the frequency of overall asthma symptoms, cough and wheezing, nighttime awakening, and activities limitations. If participants requested help with or clarification of any document, they were asked to reread the instructions and to give the answer that best reflected how they felt. The children and parents were assured that there was no right or wrong answer. The specialist did not provide any answer or attempt to interpret any portion of an item for the patient or the parent/caregiver.

Data analyses

Analyses were performed on a combined set of data from 2 previously conducted validation studies of the C-ACT. Data from the cross-sectional validation study were pooled with baseline data from the longitudinal validation study to achieve an adequate sample size of children who were classified by their physician as having either “poorly controlled” asthma or asthma that was “not controlled at all.” Variables unique to one dataset or the other were not included in the final pooled dataset.

The C-ACT was scored as the simple sum of the response codes for the 7 items. C-ACT scores range from 0 to 27, with higher scores indicating better asthma control. Only subjects with complete data on the C-ACT at baseline were included.

Statistical analyses

Sample characteristics. Demographic and clinical characteristics were summarized, and descriptive statistics were calculated for C-ACT scores.

Screening accuracy. Methods for determining the second cut point followed those used by Schatz et al.³ A binomial logistic regression analysis was conducted to test the ability of the C-ACT to classify patients as having “very poorly controlled” or “not well controlled” asthma. The specialist's global assessment of asthma control was the criterion measure. For the regression analysis, children were classified as “very poorly controlled” if the specialist's global assessment rating was either “not controlled at all” or “poorly controlled” and as “not well controlled” if the specialist's rating was “somewhat controlled.” Children with a specialist rating of “well controlled” or “completely controlled” ($n = 282$) were excluded from the regression analysis. Receiver operating characteristic (ROC) analyses were conducted to evaluate how different cut points on the C-ACT performed in predicting the specialists' assessments of asthma control. The following statistics were reported for each potential cut point: sensitivity, specificity, positive predictive value, negative predictive value, percent correctly classified, and c-statistic (area under the ROC curve).

¹The original publication on the ACT used the term “poorly controlled” or “uncontrolled” rather than “not well controlled,” and subsequent publications on the ACT have used other terms as well. In this article we use terminology consistent with the EPR3 guidelines for both the ACT and C-ACT.

Clinical validity of the selected cut point. The cut point for very poorly controlled asthma was used in conjunction with the first cut point of a score of 19 to classify children into one of 3 groups (“very poorly controlled,” “not well controlled,” and “well controlled”), which were then compared on the basis of specialist severity ratings, specialist assessment of therapy, and FEV₁ percent predicted at baseline.

Data from the longitudinal study were used to assess how the C-ACT score and FEV₁ percent predicted changed after 1 month for each group. With the second cut point for the C-ACT identifying a high-risk group of children (“very poorly controlled”) with more severe disease, children in this group might be expected to have lower C-ACT scores and FEV₁ percent predicted at follow-up compared with the other groups.

Statistical comparisons were made between the “very poorly controlled” and “not well-controlled” groups and the “not well-controlled” and “well-controlled” groups. Associations between C-ACT classifications and specialist assessments of both asthma severity and the need to change therapy were evaluated by using Mantel-Haenszel χ^2 tests. *t* Tests were used to compare differences between groups in FEV₁ percent predicted and C-ACT scores.

SAS for Windows version 9.1.3 (SAS Institute, Inc, Cary, NC) was used for all analyses. For all statistical tests, significance at a *P* value of .05 or less was used.

RESULTS

Sample characteristics

Combining the datasets from the previous cross-sectional and longitudinal studies produced a sample of 671 children who had C-ACT scores at baseline. The sample was 60.5% male and 63.8% white (North American/European) and had an average age of 7.8 years (SD, 2.3 years). The mean prebronchodilator percent predicted FEV₁ was 94.04% (SD, 19.49%). Approximately one fifth of the sample were not able to complete the spirometric test. The average C-ACT score was 19.6 (SD, 4.6) on a scale from 0 to 27. Based on specialists’ global assessment ratings, 24.7% of the children were classified as “somewhat controlled,” 15.6% were classified as “poorly controlled,” and 1.6% were classified as “not controlled at all.” Specialists rated most children’s asthma severity as “mild” (57.4%) or “moderate” (38.9%). The specialists made no change in asthma therapy for slightly more than half of the sample (55.4%), stepped up therapy for slightly more than one third of children (34.6%), and stepped down therapy for 9.1% of children. Data on change in therapy were missing for the remaining 0.9% (Table I).

Screening accuracy

We evaluated C-ACT scores ranging from 10 to 17 to represent a cut point for very poorly controlled asthma. For cut points of 12 to 17, the area under the ROC curve was 0.600 or higher, with *c*-statistics ranging from 0.610 (at a cut point score of 13) to 0.630 (at a cut point score of 17). A score of 12 was selected as the optimal cut point because it resulted in the highest percentage of correctly classified patients (66.3%) and demonstrated a high level of specificity (89.76%). A score of 12 was also associated with a moderate positive predictive value (69.1%) and area under the ROC curve (0.613, Table II).

The overall C-ACT ROC curve and the area under the curve (0.688), which measures the sensitivity and specificity of the selected set of items, indicated the adequate, but not strong, predictive value of the C-ACT score in discriminating between children with specialist ratings of “very poorly controlled” versus “not well-controlled” asthma. The result of the corresponding Hosmer and Lemeshow goodness-of-fit test was not significant (*P* = .6426), indicating the appropriateness of the logistic regression model.

TABLE I. Pooled sample characteristics (n = 671)

Variables	
Child’s sex (male)*	406 (60.5%)
Child’s ethnicity*	
Afro-Caribbean/African American	92 (13.7%)
Asian/Indian	29 (4.3%)
North African/Middle Eastern	01 (0.1%)
Hispanic/Latino/Spanish American	58 (8.6%)
North American/European/white	428 (63.8%)
Native American	5 (0.7%)
Other	56 (8.3%)
Child’s age (y)	7.80 (2.30)
Years since asthma diagnosis*	3.82 (2.62)
Prebronchodilator spirometry	
FEV ₁ (L)*	1.57 (0.50)
Percent predicted FEV ₁ *	94.04 (19.49)
FVC (L)*	1.89 (0.62)
FEV ₁ /FVC ratio*	0.84 (0.10)
C-ACT score†	19.61 (4.64)
Child’s asthma symptom score (specialist’s rating)*	
No symptoms during past 4 wk	187 (27.9%)
Symptoms for 1 short period during the past 4 wk	195 (29.1%)
Symptoms for ≥2 short periods during the past 4 wk	128 (19.1%)
Symptoms for most of the time that did not affect normal activities	76 (11.3%)
Symptoms for most of the time that did affect normal activities	73 (10.9%)
Symptoms so severe that normal activities could not be performed	7 (1.0%)
Global assessment of control (specialist’s rating)*	
Not controlled at all	11 (1.6%)
Poorly controlled	105 (15.6%)
Somewhat controlled	166 (24.7%)
Well controlled	287 (42.8%)
Completely controlled	99 (14.8%)
Child’s asthma severity (specialist’s rating)*	
Mild	385 (57.4%)
Moderate	261 (38.9%)
Severe	21 (3.1%)
Child’s asthma severity (caregiver’s rating)*	
Very mild	72 (10.7%)
Mild	228 (34.0%)
Moderate	309 (46.1%)
Severe	50 (7.5%)
Very severe	11 (1.6%)
Need to change asthma therapy (specialist’s rating)*	
Stepped-down therapy	61 (9.1%)
No change in therapy	372 (55.4%)
Stepped-up therapy	232 (34.6%)

Values are presented as numbers (percentages) or means (SDs) where shown. FVC, Forced vital capacity.

*Missing data: child’s sex, n = 1; ethnicity, n = 2; years since asthma diagnosis, n = 17; FEV₁ (L), n = 138; percent predicted FEV₁, n = 142; FVC, n = 139; FEV₁/FVC ratio, n = 142; peak expiratory flow, n = 140; asthma symptom score, n = 5; global assessment of control, n = 3; child’s asthma severity (specialist’s rating), n = 4; child’s asthma severity (caregiver’s rating), n = 1; need to change asthma therapy, n = 6.

†C-ACT scores range from 0 to 27, with higher scores indicating better asthma control.

Clinical validity of the selected cut point

Baseline. By using a second cut point score of 12 along with the original cut point score of 19, children were classified into one of 3 groups on the basis of their C-ACT score: “very poorly controlled” (score of ≤12), “not well controlled” (score of 13-19),

TABLE II. Screening accuracy: Summary of the performance of the C-ACT score at various cut points predicting specialist's assessment of asthma as "very poorly controlled" (vs "not well controlled")* at baseline (n = 282)

Cut point	Sensitivity	Specificity	Positive predictive value (%)	Negative predictive value (%)	Correctly classified (%)	c-Statistic
≤3	0.86	100.00	100.0	59.1	59.2	0.504
≤4	2.59	100.00	100.0	59.5	59.9	0.513
≤5	3.45	99.40	80.0	59.6	59.9	0.514
≤6	5.17	98.80	75.0	59.9	60.3	0.520
≤7	8.62	98.19	76.9	60.6	61.3	0.534
≤8	10.34	97.59	75.0	60.9	61.7	0.540
≤9	11.21	96.99	72.2	61.0	61.7	0.541
≤10	19.83	96.39	79.3	63.2	64.9	0.581
≤11	25.00	92.17	69.0	63.8	64.5	0.586
≤12	32.76	89.76	69.1	65.6	66.3	0.613
≤13	37.07	84.94	63.2	65.9	65.2	0.610
≤14	43.10	81.33	61.7	67.2	65.6	0.622
≤15	50.00	74.70	58.0	68.1	64.5	0.623
≤16	58.62	65.06	54.0	69.2	62.4	0.618
≤17	68.10	57.83	53.0	72.2	62.1	0.630
≤18	76.72	48.80	51.1	75.0	60.3	0.628
≤19	85.34	40.36	50.0	79.8	58.9	0.629
≤20	91.38	27.71	46.9	82.1	53.9	0.595
≤21	93.10	18.67	44.4	79.5	49.3	0.559
≤22	94.83	10.84	42.6	75.0	45.4	0.528
≤23	97.41	4.22	41.5	70.0	42.6	0.508
≤24	97.41	3.01	41.2	62.5	41.8	0.502
≤25	99.14	1.81	41.4	75.0	41.8	0.505
≤26	100.00	0.60	41.3	100.0	41.5	0.503
≤27	100.00		41.1		41.1	

*The "very poorly controlled" group is defined as children with a specialist rating of "not controlled at all" or "poorly controlled" asthma. The "not well controlled" group is defined as children with a specialist rating of "somewhat controlled" asthma.

or "well controlled" (score of ≥ 20). Of the total sample, 8.8% (59/671) were classified as "very poorly controlled" and 33.1% (222/671) as "not well controlled." Increasing asthma severity was significantly associated with decreasing level of control both for children who were classified as "very poorly controlled" versus "not well controlled" ($P = .0005$) and for those who were classified as "not well controlled" versus "well controlled" ($P < .0001$). Within the "very poorly controlled" group, 13.6% of children were subjectively rated by the physician as having severe asthma, and 64.4% were rated as having asthma of moderate severity. Of those who were classified as "not well controlled," 4.5% were classified as having severe asthma and 52.7% as having asthma that was of moderate severity. Conversely, 42.8% of children classified as "not well controlled" had mild asthma compared with 71.0% of children classified as "well controlled" (Table III).

Recommendations regarding changes in treatment differed significantly for children classified based on C-ACT score as "very poorly controlled" versus "not well controlled" ($P < .05$) and for children classified as "not well controlled" versus "well controlled" ($P < .0001$). For the "very poorly controlled" and "not well-controlled" groups, the most common treatment decision was to step up treatment. Stepped-up treatment was recommended for 72.9% of the "very poorly controlled" group compared with 53.6% of the "not well-controlled" group and only 17.9% of children classified as "well controlled" (Table III).

Differences across the 3 groups in lung function were also observed. Percent predicted FEV₁ was significantly lower for children classified as "very poorly controlled" than for children classified as "not well controlled" (79.8% vs 92.6%, respectively; $P = .0002$) and significantly lower for those classified as "not

well controlled" than for those classified as "well controlled" (92.6% vs 96.8%, respectively; $P < .05$; Table III).

Longitudinal follow-up. Of the total sample, 338 children had a follow-up visit approximately 1 month after baseline. Table IV presents C-ACT scores and FEV₁ percent predicted at follow-up stratified by the children's C-ACT score at baseline. Compared with children classified as "not well controlled" at baseline, those classified as "very poorly controlled" had significantly lower C-ACT scores (20.3 vs 17.2, $P = .0001$) and significantly lower FEV₁ percent predicted (94.5% vs 84.9%, $P = .03$) at follow-up. Children classified as "well controlled" at baseline had higher C-ACT scores at follow-up than those classified as "not well controlled" (22.7 vs 20.3, respectively; $P < .0001$), yet average scores for both groups were above the cut point of 19, indicating "well-controlled" asthma. FEV₁ percent predicted at follow-up did not differ significantly between the "well-controlled" and "not well-controlled" groups. An *ad hoc* analysis indicated that 60% of children classified as "very poorly controlled" at baseline were not classified as "well controlled" at follow-up. For children who were classified as "not well controlled" and "well controlled" at baseline, 37% and 13% were not classified as "well controlled" at follow-up, respectively. The differences were significant between the "very poorly controlled" and "not well-controlled" ($P < .05$) and between the "not well-controlled" and "well-controlled" ($P < .0001$) groups.

DISCUSSION

The C-ACT was developed to foster discussion of asthma control among parents, children, and clinicians and to assist in

TABLE III. Clinical validation of cut point: Asthma severity and change in therapy by control groups defining “very poorly controlled” with a cut point of 12 (full sample at baseline, n = 671)

	Control groups based on cut points of the C-ACT*			Very poorly controlled vs not well controlled (P value)	Not well controlled vs well controlled (P value)
	Very poorly controlled (C-ACT score ≤12), n = 59	Not well controlled (C-ACT score 13-19), n = 222	Well controlled (C-ACT score ≥20), n = 390		
Child’s asthma severity (specialist’s rating) at baseline					χ^2 test†
Mild	13 (22.0%)	95 (42.8%)	277 (71.0%)	.0005	<.0001
Moderate	38 (64.4%)	117 (52.7%)	106 (27.2%)		
Severe	8 (13.6%)	10 (4.5%)	3 (0.8%)		
Missing	—	—	4 (1.0%)		
Need to change asthma therapy (specialist’s rating) at baseline					
Stepped-down therapy	2 (3.4%)	14 (6.3%)	45 (11.5%)	.0131	<.0001
No change in therapy	14 (23.7%)	88 (39.6%)	270 (69.2%)		
Stepped-up therapy	43 (72.9%)	119 (53.6%)	70 (17.9%)		
Missing	—	1 (0.5%)	5 (1.3%)		
Percent predicted FEV ₁ (L) at baseline					t Test
No.	45	166	318	.0002	.0184
Mean (SD)	79.8 (21.20)	92.6 (19.57)	96.8 (18.26)		
Median	80.00	92.00	97.00		
Minimum-maximum	37.0-127.0	43.0-145.0	28.0-203.0		
Missing	14	56	72		

Values are presented as numbers (percentages) where shown.

*Control group based on C-ACT scores at baseline: 12 or less, “very poorly controlled”; 13 to 19, “not well controlled”; and 20 or greater, “well controlled.”

†P values are derived from Mantel-Haenszel χ^2 testing linear association between the row variable and the column variable.

accurately assessing asthma control with a validated, self-administered questionnaire that is easy to use. Items were generated based on children’s and parents’ input and selected based on their ability to differentiate children whose asthma is controlled. Combined datasets from the previous cross-sectional and longitudinal studies were used to establish a C-ACT score that would identify children whose low level of asthma control would put them at high risk of significant exacerbations.

Although the sensitivity of a cut point score of 12 was low (correctly identifying only 32.76% of children rated by the specialist as “very poorly controlled”), the specificity was high (89.76% of children were correctly classified as “not well controlled”). For a cut point score of 12, the positive predictive value was 69.1%, indicating that approximately 69.1% of those classified based on C-ACT score as “very poorly controlled” were rated by the specialist as “poorly controlled” or “not controlled at all.” A cut point score of 12 also resulted in the highest proportion of patients correctly classified overall (66.3%). This proportion is commensurate with that of the second cut point for the ACT (68.2%). Finally, because a high-risk status could have heightened management implications, a more conservative threshold was considered appropriate.

The value of a second higher-risk cut point score of 12 can be best appreciated by considering group differences in clinical outcomes. Mean percent predicted FEV₁ was 92.6% among children classified as “not well controlled” versus 79.8% among those classified as “very poorly controlled,” suggesting that lung function impairment is significantly worse ($P = .0002$) for children with a C-ACT score of 12 or less. Furthermore, for approximately 73% of children classified as “very poorly controlled,” an asthma specialist indicated that a step up in treatment was required. Stepped-up treatment was recommended for a

substantially lower proportion of those classified as “not well controlled” (54%).

When children with a C-ACT score of 12 or less returned to the specialist after 1 month, despite being more frequently stepped up in therapy, their mean C-ACT scores indicated that their asthma was not yet well controlled (C-ACT score of 17.2). In contrast, children who were classified as “not well controlled” at the baseline visit had a mean score of 20 at follow-up, indicating that most had well-controlled asthma. At the 1-month follow-up visit, mean FEV₁ percent predicted for children who were classified as “very poorly controlled” at baseline was nearly 10 percentage points lower than for children who were classified as “not well controlled” (84.9% vs 94.5%). These results suggest that more children classified as “very poorly controlled” based on a C-ACT score of 12 or less have persistent impairment at follow-up despite specialist management and therefore represent patients with relatively worse asthma control and more difficult-to-manage asthma. As such, these findings would inform heightened risk assessment and need for a change in management. Use of the C-ACT provides an opportunity for the clinician and the family to explore barriers to optimal control, such as comorbidities or adherence issues.

The sample on which these analyses were performed included a relatively small proportion of children with severe asthma and was predominantly white, potentially limiting the generalizability of the findings. Future studies in more severe and ethnically diverse samples would be beneficial in adding to the body of evidence on the C-ACT. Additionally, because the current analysis was done retrospectively with data from 2 separate studies of different design, a large prospective study would provide important validation of the results presented in this article. It is possible that the performance characteristics of the C-ACT in identifying patients with “very poorly controlled” asthma could be improved by

TABLE IV. Clinical validation of cut point: C-ACT score and percent predicted FEV₁ by control group defining “very poorly controlled” with a cut point of 12 for longitudinal sample at baseline and follow-up (n = 338)

	Control groups based on cut points of the C-ACT*			t Test	
	Very poorly controlled (C-ACT score ≤12), n = 37	Not well controlled (C-ACT score 13-19), n = 124	Well controlled (C-ACT score ≥20), n = 176	Very poorly controlled vs not well controlled (P value)	Not well controlled vs well controlled (P value)
C-ACT score at baseline					
No.	37	124	176	<.0001	<.0001
Mean (SD)	9.2 (2.69)	16.7 (1.80)	22.9 (2.06)		
Median	10.00	17.00	23.00		
Minimum-maximum	3.0-12.0	13.0-19.0	20.0-27.0		
Missing/no response	0	0	0		
C-ACT score at follow-up					
No.	33	118	163	.0001	<.0001
Mean (SD)	17.2 (5.42)	20.3 (3.64)	22.7 (3.05)		
Median	17.00	21.00	23.00		
Minimum-maximum	5.0-26.0	9.0-27.0	12.0-27.0		
Missing	4	6	13		
Not “well controlled” at follow-up†	60%	37%	13%	.0128	<.0001
Percent predicted FEV₁ (L) at baseline					
No.	26	92	147	.0253	.0006
Mean (SD)	80.3 (21.72)	90.3 (19.45)	98.6 (16.54)		
Median	79.00	89.00	100.00		
Minimum-maximum	50.0-127.0	43.0-137.0	48.0-150.0		
Missing	11	32	29		
Percent predicted FEV₁ (L) at follow-up					
No.	24	80	134	.0329	.4258
Mean (SD)	84.9 (18.58)	94.5 (19.10)	96.5 (16.70)		
Median	85.00	94.50	100.00		
Minimum-maximum	31.0-114.0	37.0-135.0	39.0-134.0		
Missing	13	44	42		

Values are shown as numbers (percentages) where shown.

*Control group based on C-ACT score at baseline: 12 or less, “very poorly controlled”; 13-19, “not well controlled”; and 20 or greater, “well controlled.”

†Calculated as percentage of subjects with nonmissing data.

adding or subtracting items from the instrument, changing administration procedures, and/or changing scoring procedures; these matters could be assessed in future studies.

Although further evaluation will be valuable, the data presented in this article indicate that the C-ACT can help identify children with very poorly controlled asthma and further support its use as an important assessment tool in facilitating communication among patients, caregivers, and physicians on asthma control and in asthma management. Prior studies have shown that children whose asthma is not well controlled, as indicated by C-ACT scores of 19 or less, tend to be at increased risk for emergency department visits^{6,7} and have significantly more asthma exacerbations relative to children whose asthma is well controlled.⁶ It is possible that, within this group, children with very poorly controlled asthma have the worst outcomes. Identifying a second cut point on the C-ACT would help identify children at increased risk for continuing to have asthma that is not well controlled and deserving of heightened risk assessment and management in accordance with current national and international guidelines.

In conclusion, these analyses demonstrate that a second cut-point score of 12 on the C-ACT best identifies children at higher risk because of poorly controlled asthma. This second cut point has adequate accuracy characteristics and good clinical validity, is conceptually consistent with national and international asthma management guidelines that stratify asthma control into 3

categories, and might help clinicians to guide therapy more appropriately in children with uncontrolled asthma.

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Clinical implications: Given validated findings, newly established C-ACT levels in children 4 to 11 years of age fit the recommended National Asthma Education and Prevention Program guidelines' 3-level asthma control classification: score of 20 or greater, well controlled; score of 13 to 19, not well controlled; and score of 12 or less, very poorly controlled.

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Enter Name _____

Today's Date: _____

Enter Address _____

Patient's Name: _____

Enter City/State/Zip _____

Childhood Asthma Control Test for children 4 to 11 years.

This test will provide a score that may help the doctor determine if your child's asthma treatment plan is working or if it might be time for a change.

How to take the Childhood Asthma Control Test

Step 1 Let your child respond to the first four questions (1 to 4). If your child needs help reading or understanding the question, you may help, but let your child select the response. Complete the remaining three questions (5 to 7) on your own and without letting your child's response influence your answers. There are no right or wrong answers.

Step 2 Write the number of each answer in the score box provided.

Step 3 Add up each score box for the total.

Step 4 Take the test to the doctor to talk about your child's total score.

**19
or less**

If your child's score is 19 or less, it may be a sign that your child's asthma is not controlled as well as it could be. Bring this test to the doctor to talk about the results.

Have your child complete these questions.

1. How is your asthma today?

 0 Very bad	 1 Bad	 2 Good	 3 Very good
---	--	---	--

SCORE

2. How much of a problem is your asthma when you run, exercise or play sports?

 0 It's a big problem, I can't do what I want to do.	 1 It's a problem and I don't like it.	 2 It's a little problem but it's okay.	 3 It's not a problem.
---	---	--	---

3. Do you cough because of your asthma?

 0 Yes, all of the time.	 1 Yes, most of the time.	 2 Yes, some of the time.	 3 No, none of the time.
--	---	---	--

4. Do you wake up during the night because of your asthma?

 0 Yes, all of the time.	 1 Yes, most of the time.	 2 Yes, some of the time.	 3 No, none of the time.
--	---	---	--

Please complete the following questions on your own.

5. During the last 4 weeks, how many days did your child have any daytime asthma symptoms?

5 Not at all	4 1-3 days	3 4-10 days	2 11-18 days	1 19-24 days	0 Everyday
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6. During the last 4 weeks, how many days did your child wheeze during the day because of asthma?

5 Not at all	4 1-3 days	3 4-10 days	2 11-18 days	1 19-24 days	0 Everyday
------------------------	----------------------	-----------------------	------------------------	------------------------	----------------------

7. During the last 4 weeks, how many days did your child wake up during the night because of asthma?

5 Not at all	4 1-3 days	3 4-10 days	2 11-18 days	1 19-24 days	0 Everyday
------------------------	----------------------	-----------------------	------------------------	------------------------	----------------------

TOTAL

FIG E1. Childhood Asthma Control Test (C-ACT). Copyright GlaxoSmithKline 2006.