Original Article

Assessment of Control of Bronchial Asthma in Children Using Childhood Asthma Control Test

Shiva Prasad Chalise, Nisha K. Bhatta, Rupa R. Singh, Maya Shankar Prasad and Prakash Poudel

Department of Pediatrics and Adolescent Medicine, B.P. Koirala Institute of Health Sciences, Dharan, Nepal

Abstract

Background. The use of Childhood Asthma Control Test (C-ACT) has been advised for monitoring asthma control by the Global Initiative for Asthma (GINA) guidelines.

Objective. To validate the tool C-ACT for the assessment of control of asthma and to examine the correlation between C-ACT score and lung function assessed by forced expiratory volume in one second (FEV_1).

Methods. This was a prospective observational study conducted between January 2010 to January 2011. Children diagnosed to have bronchial asthma and aged 5 to 14 years, were enrolled in the study. Asthma severity and control status were classified according to the National Asthma Education and Prevention Programme (NAEPP) and GINA guidelines, respectively. Patients were followed-up at three and six months and C-ACT and spirometric measurements were obtained.

Results. Significant positive correlations were found between C-ACT score and FEV_1 at enrollment ($r=0.772$) ($p<0.001$), three months ($r=0.815$) ($p<0.001$) and at six months follow-up ($r=0.908$) ($p<0.001$). Baseline C-ACT score was useful for predicting the levels of control of asthma upto three months (0.004), but not at six months follow-up (0.787). A cut-off C-ACT value of $\geq$19 had a sensitivity, specificity, positive predictive value, negative predictive value and area under the curve (AUC) 98.5%, 89.1%, 94.9%, 96.6%, 0.717, respectively for the control of asthma.

Conclusion. C-ACT is a simple and feasible tool to assess and predict the levels of control in children with bronchial asthma upto three months. **[Indian J Chest Dis Allied Sci 2014;56:75-78]**

Key words: Childhood asthma, FEV_1, Childhood Asthma Control Test.

Introduction

Asthma is a chronic inflammatory disorder of the airways resulting in episodic airflow obstruction. Chronically inflamed airways are hyperresponsive and airflow is limited by bronchoconstriction, mucus plugs, inflammatory mucosal oedema of the airways. An estimated 300 million people worldwide suffer from asthma, with 250,000 annual deaths attributed to the disease.[1] The prevalence of asthma in eastern region of Nepal is about 4% (unpublished data).

Asthma has a potential adverse effect on the patient and the society in terms of morbidity, quality of life, physical activity, education, socialisation and self-esteem, disability-adjusted life years (DALYs) including school absence and health care costs. Hence, early diagnosis and appropriate treatment of asthma is critical to decrease the impacts. It is important to evaluate the severity and monitor the level of control regularly and adjust therapy to achieve and maintain clinical control. In the Global Initiative for Asthma (GINA) 2006 guidelines, the level of control of the disease was classified into controlled, partly controlled, and uncontrolled disease status, taking into account day-time and nocturnal symptoms, exercise limitation, pulmonary function, beta-2-agonist use, and disease exacerbation and forced expiratory volume in one second (FEV_1).[2] Tools used to assess the asthma control are spirometry, validated questionnaires for assessing asthma control like Childhood Asthma Control Test (C-ACT),[3] Disease Severity Score (DSS)[4] and fractional exhaled nitric oxide (FeNO) concentration.[5] Spirometry and FeNO measurements are usually not available in the primary care setting.

Questionnaires are simplified tools and convenient option to assess asthma control as these do not require any particular equipment.[6-8] The C-ACT is a simple, self-administered questionnaire with seven items that assesses asthma symptoms, use of rescue medications, and the effect of asthma on daily functioning in the preceding four weeks. The C -ACT has been found to predict the change in clinical status in asthmatics in children. There is paucity of reports on the assessment of control of asthma in south Asian region including Nepal. Hence, this study was carried out to validate the C-ACT in evaluating asthma control in Nepalese children by comparing with FEV_1; and also to examine the correlation between C-ACT and FEV_1.

[Received: December 12, 2012; accepted after revision: November 26, 2013]

Correspondence and reprint requests: Dr Shiva Prasad Sharma Chalise, Department of Pediatrics and Adolescent Medicine, B.P. Koirala Institute of Health Sciences, Dharan, Nepal; Phone: 977-9851129339; Fax: 977-25-520251; E-mail: ascol04@yahoo.com

Material and Methods

An observational study was carried out at the Department of Pediatrics and Adolescent Medicine, B.P. Koirala Institute of Health Sciences (BPKIHS), Dharan, Nepal during the period January 2010 to January 2011. All the children aged 5–14 years presenting to BPKIHS and with asthma diagnosed by clinical assessment and the GINA guidelines were enrolled in the study. Children who were unable to perform spirometry, asthma with other known chronic systemic disorders including other respiratory diseases, central nervous system disorders, cardiovascular diseases, and renal diseases, and patients on chronic medication, like steroids, were excluded from the study. The study was approved by Clinical Protocol Committee and Ethics Committee of BPKIHS. Disease severity and level of control were evaluated according to the National Asthma Education and Prevention Programme (NAEPPA) guidelines[9] and GINA guidelines,[2] respectively. Written informed consent was obtained from the parents.

Spirometery was carried out and C-ACT was administrated by the treating physician. The C-ACT score and FEV_1 was recorded at enrollment, at three and six months. In the C-ACT questionnaire, the first four items were answered by the children, and items 5 to 7 were answered by their parents. The Nepali version of C-ACT was used. The patients were managed according to GINA guidelines.

Spirometry was done by the same investigator and with a hand-held *KoKo Peak Pro 6* spirometer and Schiller SP-260. Data were recorded and analysed by one-way analysis of variance (ANOVA) using Statistical Package for the Social Sciences (SPSS) (version 11.5).

Results

Seventy-three children with bronchial asthma between the age group of 5 to 14 years were studied. Five out of them could not perform spirometry, hence, excluded from the study and three were lost to follow-up. Thus, 65 children completed the study. Thirty-five (53.8%) patients were between 5 to 9 years and 30 (46.2%) patients were between 10 to 14 years of age. Thirty-five (53.8%) were males and the remaining 30 (46.2%) were females.

The most common risk factors for asthma were history of bronchiolitis with hospitalisation in 14 (21.5%) followed by a history of parental asthma in 12 (18.5%), history of pneumonia in 8 (12.3%) and allergic rhinitis in 6 (9.2%). Other risk factors were wheezing apart from cold 4 (6.2%) and atopic dermatitis 3 (4.6%).

Most of the children had moderate persistent 22 (34%) or mild persistent 21 (32%) asthma. The remaining belonged to mild intermittent 16 (25%) and severe persistent 6 (9%) asthma groups. According to the level of control, partly controlled asthma was found in 31 (47.7%) followed by controlled 28 (43.1%) and uncontrolled asthma 6 (9.2%) at baseline.

Table 1 shows FEV_1 and C-ACT score at enrollment, three months and six months among the controlled, partly controlled and uncontrolled children with asthma.

Significant positive correlations were found between C-ACT score and FEV_1 at enrollment (r=0.772) (p<0.001), three months (r=0.815) (p<0.001) and at six months follow-up (r=0.908) (p<0.001) (Figure 1).

Table 1. C-ACT score and FEV_1 on all the visits.

	At Enrollment		At 3 months		At 6 month	
	FEV_1	C-ACT	FEV_1	C-ACT	FEV_1	C-ACT
Controlled	86.9	23.4	89.66	23.5	91.94	24.06
Partly controlled	74.45	15.6	74.66	18.83	73.11	17.33
Uncontrolled	55.66	11.5	52.33	14.33	58.33	15.00

Definition of abbreviations: C-ACT=Childhood Asthma Control Test; FEV_1=Forced expiratory volume in one second

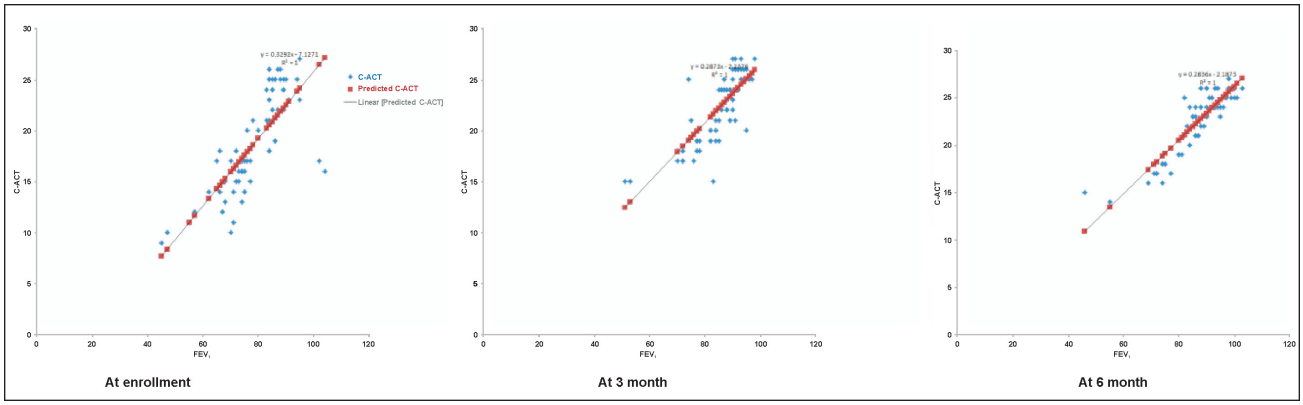

Figure 1. Scatter diagram of C-ACT score and FEV_1 at enrollment, 3 months and 6 months.

Definition of abbreviations: C-ACT=Childhood Asthma Control Test; FEV_1=Forced expiratory volume in one second

The C-ACT score cut-off value of ≥19 had sensitivity, specificity, positive predictive value, negative predictive value and area under the curve (AUC) 98.5%, 89.1%, 94.9%, 96.6%, 0.717, respectively to detect controlled asthma. The AUC was the highest at a cut-off value 19 (Table 2, Figure 2).

Table 2. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and area under the curve (AUC) of C-ACT score to detect controlled asthma.

Score	Sensitivity	Specificity	PPV	NPV	AUC
17	99.2%	50%	80.2%	97%	0.667
18	99.2%	73.4%	88.4%	97.9%	0.710
19	**98.5%**	**89.1%**	**94.9%**	**96.6%**	**0.717**
20	93.9%	93.8%	96.1%	88.3%	0.686
21	89.3%	95.3	97.5%	81.3	0.688
22	80.9%	98.4%	99.1%	71.6%	0.669

Definition of abbreviations: **C-ACT=Childhood Asthma Control Test**

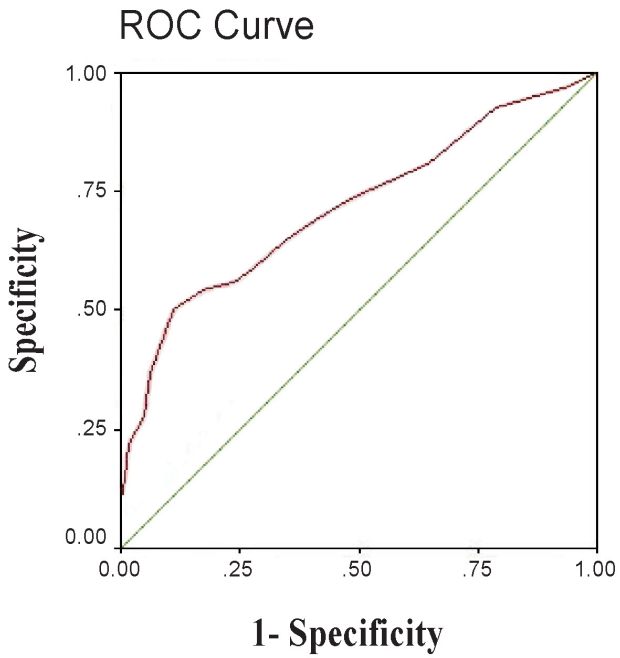

Figure 2. ROC curve of C-ACT score at cut-off value of ≥19.

Definition of abbreviations: ROC=Reciver Operating Characteristic; C-ACT=Childhood Asthma Control Test

It was observed that C-ACT score at enrollment was useful for predicting the levels of control of asthma at enrollment ($p<0.001$) and three months follow-up visit ($p=0.004$). However, it was not useful for predicting level of control of asthma at six months follow-up ($p=0.787$). The FEV_1 at enrollment was compared with the level of control of asthma at three months and six months follow-up. The FEV_1 score was found to predict the level of control of asthma at enrollment and at three months ($p<0.01$) but not at six months follow-up ($p=0.315$).

Discussion

The C-ACT has been translated in many languages and is in use as a tool for assessing control of asthma.[10,11] The FEV_1, a measure of the degree of airway obstruction in asthma, is a well established parameter for assessing control of asthma.[12] The GINA and NAEPP guidelines include FEV_1 as a major objective tool for classification of severity and control of asthma. The FEV_1 has also been studied as a predictor of control and occurrence of exacerbations in a longitudinal study.[13]

We have evaluated the usefulness of C-ACT and FEV_1 in children with different levels of control of asthma at enrollment and follow-up visits (3 months and 6 months). Significant positive correlations were found between C-ACT and FEV_1 which indicate that C-ACT is a useful test in assessing the level of control in asthmatic children. The results of this study are similar to those reported by Zhou *et al*[10] who found that the five-item C-ACT had an internal consistency reliability of 0.861 and a correlation coefficient with the specialists' rating of 0.697 between FEV_1 and C-ACT score. Alvarez-Gutiérrez *et al*[11] also found a modest correlation between baseline FEV_1 and C-ACT score ($r=0.19$, $P<0.01$).

It was observed that C-ACT score at enrollment was useful for predicting the levels of control of asthma at enrollment and three months but not at six months follow-up. This result is in contrast to the study done by Leung *et al*[14] where they found that the C-ACT can be useful for prediction of asthma exacerbations up to six months. Seasonal variance, change or stoppage of asthma medication and poor socioeconomic and educational status of Nepalese parents may have contributed to poor prediction of control of asthma at the six months follow-up.

On longitudinal analysis, FEV_1 at enrollment was significantly associated with the level of control of asthma at three months but it was not significant at six months. This shows that FEV_1 can be used to predict the control status upto three months. This finding is similar to the study done by Fuhlbrigge *et al*[13] who found that lower FEV_1 predicts exacerbation upto four months and Kitch *et al*[15] who found that patients with FEV_1% predicted of 60% to 69% had a greater risk of an attack than those with an FEV_1% predicted of 70% to 79% over the next three years.

A cut-off value of C-ACT score ≥19 had a sensitivity of 98.5%, a specificity of 89.1%, a positive predictive value of 94.9%, a negative predictive value of 96.6% and an AUC of 0.717. Liu *et al*[3] found a lower sensitivity (74%) and specificity (68%) at a score of 19. Schatz *et al*[7] demonstrated still lower sensitivity and specificity both of 71% at a score of 19. Alvarez-Gutiérrez *et al*[11] obtained the cut-off C-ACT > or =21 (AUC 0.791) and for uncontrolled > or =21. In both the studies, the maximum AUC was at a cut-off value of 19. Lai *et al*[16]

found that the optimal C-ACT cut-off score for identifying uncontrolled asthma was ≤19 for subjects aged less than 12 years. Other researchers[8,17] had also demonstrated lower sensitivity and specificity at a cut-off level of 19 in their studies; however the high sensitivity and specificity in our study indicates that it is a useful test and can be applied to assess the level of control in children suffering from bronchial asthma.

Conclusions

We conclude that C-ACT is a simple and feasible test to assess the levels of control of asthma in children suffering from bronchial asthma. It is a suitable alternative to FEV_1 especially in situations where spirometry cannot be performed or is not available. Its use can help in achieving a better control of the disease and improving the quality of life.

Acknowledgements

Authors are thankful to Dr Narendra Bhatta, Professor, Internal Medicine and other staff members of Spirometry Unit for their help during spirometry. No financial support was obtained for the study.

References

1. Masoli M, Fabian D, Holt S, Beasley R. The global burden of asthma: executive summary of the GINA Dissemination Committee Report. *Allergy* 2004;59:469-78.
2. Global Strategy for Asthma Management and Prevention, Global Initiative for Asthma (GINA) 2011. *Available at URL*: http://www.ginasthma.org.
3. Liu AH, Zeiger R, Sorkness C, Mahr T, Ostrom N, Burgess S, *et al*. Development and cross-sectional validation of the Childhood Asthma Control Test. *J Allergy Clin Immunol* 2007;119:817-25.
4. Brooks SM, Bernstein IL, Raghuprasad PK, Maccia CA, Mieczkowski L. Assessment of airway hyperresponsiveness in chronic stable asthma. *J Allergy Clin Immunol* 1990;85:17-26.
5. Kowal K, Bodzenta-Lukaszyk A, Zukowsk S. Exhaled nitric oxide in evaluation of young adults with chronic cough. *J Asthma* 2009;46:692-8.
6. Ehrs PO, Nokela M, Bjo¨rn Sta¨llberg, Hjemdah Pl, Jonsson EW. Brief questionnaires for patient-reported outcomes in asthma: validation and usefulness in a primary care setting. *Chest* 2006;129:925-32.
7. Schatz M, Sorkness CA, Li JT, Marcus P, Murray JJ, Nathan RA, *et al*. Asthma Control Test: reliability, validity, and responsiveness in patients not previously followed by asthma specialists. *J Allergy Clin Immunol* 2006;117:549-56.
8. Liu AH, Zeiger RS, Sorkness CA, Ostrom NK, Chipps BE, Rosa K, *et al*. The Childhood Asthma Control Test: retrospective determination and clinical validation of a cut point to identify children with very poorly controlled asthma. *J Allergy Clin Immunol* 2010;126:267-73.
9. The National Asthma Education and Prevention Program. Guidelines for the Diagnosis and Management of Asthma. Bethesda: National Institute of Health, National Heart, Lung , and Blood Institute. Expert Panel Report II. 2007.
10. Zhou X, Ding FM, Lin JT, Yin KS. Validity of asthma control test for asthma control assessment in Chinese primary care settings. *Chest* 2009;1354:904-10.
11. Alvarez-Gutiérrez FJ, Medina-Gallardo JF, Pérez-Navarro P, Martín-Villasclaras JJ, Martin Etchegoren B, Romero-Romero B, *et al*. Comparison of the Asthma Control Test (ACT) with lung function, levels of exhaled nitric oxide and control according to the Global Initiative for Asthma (GINA). *Arch Bronconeumol* 2010;46:370-7.
12. Fuhlbrigge AL, Weiss ST, Kuntz KM, Paltiel AD. Forced expiratory volume in 1 second percentage improves the classification of severity among children with asthma. *Pediatrics* 2006;118:e347.
13. Fuhlbrigge AL, Kitch BT, Paltiel AD, Kuntz KM, Neumann PJ, Dockery DW, *et al*. FEV(1) is associated with risk of asthma attacks in a pediatric population. *J Allergy Clin Immunol 2*001;107:61-67.
14. Leung TF, Ko FW, Wong GW, Li CY, Yung E, Hui DS, *et al*. Wong predicting changes in clinical status of young asthmatics: clinical scores or objective parameters? *Pediatric Pulmonol* 2009;44:442-49.
15. Kitch BT, Paltiel AD, Kuntz KM, Dockery DW, Schouten JP, Weiss ST, *et al.* A single measure of FEV1 is associated with risk of asthma attacks in long-term follow-up. *Chest* 2004;126:1875-82.
16. Lai CK, Ko FW, Bhome A, DE Guia TS, Wong GW, Zainudin BM, *et al*. Relationship between asthma control status, the Asthma Control Test™ and urgent health-care utilization in Asia. *Respirology* 2011;16:688-97.
17. Schatz M, Kosinski M, Sorkness C. Comparison of two patient based measures of asthma control: ACT and ACQ. *Proceedings of American Thoracic Society International Conference*. Philadelphia: American Thoracic Society; 2005:A255.