ASTHMA ALLERGY IMMUNOLOGY
ASTIM ALLERJİ İMMÜNOLOJİ

doi: 10.21911/aai.607
Asthma Allergy Immunol 2021;19:136-141

RESEARCH ARTICLE

Received: 04.01.2021 • Accepted: 05.04.2021
Online Published: 09.07.2021

Assessment of Clinical Asthma Score and Asthma Severity Score in Preschool Children with Recurrent Wheezing

Nurdan ÇİFTCİ[1], Emine VEZİR[2], Bülent ALİOĞLU[3]

[1] Department of Pediatric Endocrinology, Inonu University Turgut Ozal Medical Center, Malatya, Turkey
[2] Department of Pediatric Allergy and Immunology, University of Health Sciences, Ankara Training and Research Hospital, Ankara, Turkey
[3] Department of Pediatric Hematology and Oncology, University of Health Sciences, Ankara Training and Research Hospital, Ankara, Turkey

Corresponding Author: Emine VEZİR ✉ eminevezir@gmail.com

This study was presented at the "European Academy of Allergy and Clinical Immunology Congress 01-05 June 2019, Lisbon, Portugal" and the abstract has been published in the Allergy Journal Volume 74, Supplement 106, August 2019.

ABSTRACT

Objective: There is no definitive consensus on asthma exacerbation scoring for preschool children with recurrent wheezing. The Clinical Asthma Score (CAS) and Asthma Severity Score (ASS) are two scoring systems that can be used in this population. The aim of this study was to evaluate the relationship between CAS and ASS, acute treatment, and exacerbation outcomes in preschool children with wheezing.

Materials and Methods: The study included 70 patients aged 2-5 years who presented to the pediatric emergency department due to an acute wheezing episode. CAS and ASS were evaluated at exacerbation presentation and after initial salbutamol therapy.

Results: Presenting scores were significantly higher among patients who had three or more episodes within the last year (p=0.01 for CAS, p=0.019 for ASS). Presenting scores were significantly higher in patients treated with systemic steroid therapy during the episode compared to those who were not (p=0.006 for CAS; p=0.003 for ASS). CAS and ASS predicted the use of acute steroid therapy with a sensitivity of 73.7% and 52.6%, and predicted hospitalization with a sensitivity of 95% and 82.5%, respectively.

Conclusion: Our data suggest that these scoring systems can be used to judge the need for systemic steroid therapy and that high scores are associated with greater likelihood of hospital admission.

Keywords: Asthma score, children, hospitalization, wheezing, exacerbation

INTRODUCTION

Acute episodes of wheezing are common in children aged 5 years or younger and are usually associated with repeated viral upper respiratory tract infections. The different phenotypes vary in terms of treatment response and prognosis. It is difficult to determine which infants or young children are more likely to develop asthma in clinical practice (1,2).

The Clinical Asthma Score (CAS) is used to evaluate the severity of asthma exacerbations in patients aged 1–5 years. Although this scoring system was previously used for older children, it can also be used for preschool children with asthma because it includes physiological measurements and clinical findings that indicate asthma severity. CAS criteria include respiratory rate, wheezing, retraction, dyspnea, and inspiration to expiration (I:E) ratio (3). The Asthma Severity Score (ASS) was developed by Gorelick et al. (4) as an alternative asthma scoring system that evaluates clinical findings (wheezing, air entry, retraction, prolonged expiration, tachypnea, and mental status) in asthma patients. There is no definitive consensus on a scoring system for asthma exacerbation severity in patients younger than 5 years of age with recurrent wheezing. Clinical scores can be simple and low-cost tools to assess the severity of respiratory distress in all pediatric

ORCID Nurdan Çiftci / 0000-0002-8203-3572, Emine Vezir / 0000-0002-0639-7358, Bülent Alioğlu / 0000-0002-1086-780X

age groups (5). In emergency departments, severity scores are generally used to determine whether the patient requires admission or can be safely discharged (6-7).

In the present study, we evaluated the scores at presentation and after initial therapy in preschool children with recurrent wheezing using two clinical scoring systems (CAS, ASS) and examined their relationship with exacerbation frequency and their role in patient management.

MATERIALS and METHODS

The study included 70 preschool patients (2-5 years old) who presented to the pediatric emergency department of our hospital between January and April 2016 due to an acute episode of recurrent wheezing (occurring at least twice). The guardians of the patients were asked whether the children had ever had wheezing before or been prescribed inhaled salbutamol therapy by a physician, in order determine if the patients had previously experienced a wheezing episode. The scoring forms and the standardized ones for all the patients were filled in by the same researcher. Comparisons were made between patients with three or more acute episodes and those with two acute episodes within the last year, and between patients who were discharged after the acute episode and those who were hospitalized.

Criteria for hospital admission were clinical signs of severe exacerbation, no clinical response to the initial inhaled salbutamol treatment, persistent tachypnea, and doubt regarding the family's ability to treat the patient at home (8). Patients presenting with mild to moderate exacerbation who responded to salbutamol treatment and showed resolution of tachypnea, increased saturation, and stable clinical condition were discharged with recommendations. Steroid therapy was added for patients with severe asthma exacerbation and those who continued to require treatment after initial therapy.

Scores were evaluated in all patients at the time of presentation to the hospital and after initial salbutamol treatment. An additional evaluation was made at 24 hours of follow-up in patients who were eligible for hospitalization.

CAS assessment included the respiratory rate, wheezing, retraction, dyspnea, and I:E ratio (minimum 0, maximum 10 points) (3), while ASS assessment included wheezing, air entry, retraction, prolonged expiration, tachypnea, and mental status (minimum 0, maximum 2 points). Higher scores indicate more severe exacerbation (4).

Patients who had chronic disease (e.g., lung disease other than asthma, kidney failure, liver failure, diabetes, leukemia, thyroid function disorder), who had a history of drug use (except asthma medications) within the last month for any reason, and those who had marked infiltration on the chest x-ray (if performed) were excluded from the study.

The ethics committee of our hospital approved the study, and the parents of all patients provided written informed consent. (date: 25.05.2016; no: 642 / 5404)

Statistical Analysis

Statistical analyses were performed using the SPSS version 20.0 software. Normality of data distributions was tested using visual (histogram and probability charts) and analytical methods (Kolmogorov–Smirnov/Shapiro–Wilk tests). Descriptive analyses were presented as mean and standard deviation for normally distributed variables and as median and interquartile range (IQR) for non-normally distributed variables. Normally distributed numerical data were compared using the independent-samples t-test and non-normally distributed numerical data were compared using the Mann–Whitney U test. Pearson's chi-square and Fisher's exact tests were used to compare frequency rates of categorical variables. Correlations between measurements were evaluated using Pearson and Spearman correlation analyses. The predictive power of the scoring systems was evaluated using receiver operating characteristic (ROC) curve analysis. Sensitivity, specificity, and threshold values were determined based on the ROC curves. The area under the curve (AUC) varies between 0.5 and 1, with higher values indicating higher reliability of the test. A p value less than 0.05 was considered statistically significant.

RESULTS

Seventy patients were included in the study. The demographic characteristics and laboratory results of the patients are presented in Table I. Three of the patients had fever (≥38°C) and four had low oxygen saturation (≤92%). Fifty-four patients had tachypnea. All patients used inhaled salbutamol therapy, eight used inhaled ipratropium bromide, 38 used systemic steroid therapy, and six used ipratropium bromide and systemic steroid

therapy. Thirty patients (42.9%) were discharged after three doses of salbutamol and 35 (50%) were followed up in the emergency inpatient department. Three patients (4.3%) were admitted to the pediatric department and two (2.9%) were admitted to the pediatric intensive care unit.

Skin prick tests were performed for 47 patients in the study. Only three of these patients had atopy (house dust mite in one, house dust mite and cockroach in one, and cat dander and mold in one patient). Eleven (15.7%) patients had atopic dermatitis. The median (IQR) CAS values of the patients with and without atopic dermatitis were 8 (3–10) and 6 (3–10), respectively (p=0.66), and their median ASS values were 5 (3–11) and 4 (1–11), respectively (p=0.373). Median (IQR) CAS values at presentation and after initial salbutamol therapy (post-treatment) were 6 (5–8) and 3 (2–5), respectively (p<0.001). Median (IQR) presenting and post-treatment ASS values were 4 (3–6) and 2 (1–4), respectively (p<0.001). There was a significant correlation between CAS and ASS scores at presentation and after initial treatment (p<0.001). CAS and ASS scores were strongly correlated at both time points (presenting: r=0.909; post-treatment: r=0.875).

Presenting and post-treatment scores were compared between patients who were discharged (n=30) and those who were hospitalized after initial salbutamol therapy (n=40). Median (IQR) presenting and post-treatment CAS values were 4.5 (4–6) and 2 (1–2) in the discharged patients versus 8 (6–9) and 4 (4–6) in the hospitalized patients, respectively. Median presenting and post-treatment ASS values were 3 (2–4) and 1 (0–1) in the discharged patients versus 6 (4–7) and 3 (2–5) in the hospitalized patients, respectively. Scores in both scales were significantly higher in the hospitalized patients compared to the discharged ones both at presentation and after initial salbutamol therapy (p<0.001 for all). Score distributions of discharged and hospitalized patients are shown in Table II.

The utility of the two scoring systems for predicting the need for hospitalization was evaluated using ROC curves. A cut-off value of 5.5 for CAS was found to have the highest sensitivity and specificity (82.5% and 73.3%, respectively). For ASS, a cut-off value of 3.5 had the highest sensitivity and specificity (95% and 63.3%, respectively). Both scoring systems discriminated between hospitalized and discharged patients (p<0.001 for both). The ROC curves predicting hospitalization are shown in Figure 1. The sensitivity, specificity, negative predictive values, and positive predictive values of CAS and ASS scores for hospitalization are shown in Table III.

We also compared presenting scores in patients who were treated with systemic steroids (either by oral/intravenous routes) during the acute episode and those who were not (Table IV). The median (IQR) presenting CAS values of patients who did and did not receive systemic steroid therapy were 7 (5–9) and 5 (4–7.5), respectively. For ASS, the median scores in these groups were 6 (4–7)

Table I: Demographic characteristics and laboratory results of patients.

	Patients (n=70)
Age (month)	41.50 (33-55)
Gender (male/female)	43/27
Weight (kg)	15.0 (13-18)
Height (cm)	95.0 (90-105)
Eosinophil count	200 /mm^3 (100-400)
Percentage of eosinophils (%)	1.65 (0.85-3.5)
Presence of eosinophilia, n (%)	14 (20)
Absolute lymphocyte count	2550 /mm^3 (1900-3600)
Absolute neutrophil count	6300 /mm^3 (3900-9450)
C-reactive protein (mg/dl)	0.78 (0.41-1.58)
Erythrocyte sedimentation rate (mm/h)	9.5 (5-16)

Table II: Clinical asthma score and asthma severity score distributions of patients discharged or hospitalized after wheezing exacerbation.

Characteristic*	**Patients Hospitalized After Attack** (n=40)	**Patients Discharged After Attack** (n=30)	***p***
Presenting CAS	8 (6-9)	4.5 (4-6)	**<0.001**
Post-attack CAS	4 (4-6)	2 (1-2)	**<0.001**
Presenting ASS	6 (4-7)	3 (2-4)	**<0.001**
Post-attack ASS	3 (2-5)	1 (0-1)	**<0.001**

* Data presented as median (interquartile range).

and 4 (2–5), respectively. Both scores were significantly higher in patients who were treated with systemic steroid therapy during exacerbations compared to those who were not (CAS: p=0.006; ASS: p=0.003).

The ability of the scoring systems to predict systemic steroid administration was evaluated using ROC curve analysis. At a cut-off value of 5.5, presenting CAS had a sensitivity of 73.7% and specificity of 59.4%. At a cut-off of 5.5 for ASS, sensitivity and specificity values were 52.6% and 81.3%, respectively. Both scoring systems had utility in predicting systemic steroid therapy (CAS: p=0.006; ASS: p=0.003). The ROC curves predicting systemic steroid therapy are shown in Figure 2.

Table III: CAS and ASS scores in predicting hospitalization.

	Hospitalized (n)	Discharged (n)	Total
CAS score positive (>5.5)	33	8	41
CAS score negative (<5.5)	7	22	29
ASS score positive (>3.5)	38	11	49
ASS score negative (<3.5)	2	19	21
Total	40	30	70
Sensitivity (CAS)/(ASS)	(33/40*100)/(38/40*100)	(82.5%)/(195%)	
Specificity (CAS)/(ASS)	(22/30*100)/(19/30*100)	(73.3%)/(63.3%)	
PPV (CAS)/(ASS)	(33/41*100)/(38/49*100)	(80.5%)/(77.5%)	
NPV (CAS)/(ASS)	(22/29*100)/(19/21*100)	(75.9%)/(90.5%)	

PPV: Positive predictive value, **NPV:** Negative predictive value.

Table IV: Presenting scores of patients treated and not treated with systemic steroid therapy during an acute wheezing episode.

Characteristic*	Patients treated with systemic steroid therapy during attack (n=38)	Patients not treated with systemic steroid therapy during attack (n=32)	*P*
Presenting CAS	7 (5-9)	5 (4-7.5)	**0.006**
Presenting ASS	6 (4-7)	4 (2-5)	**0.003**

* Data presented as median (IQR).

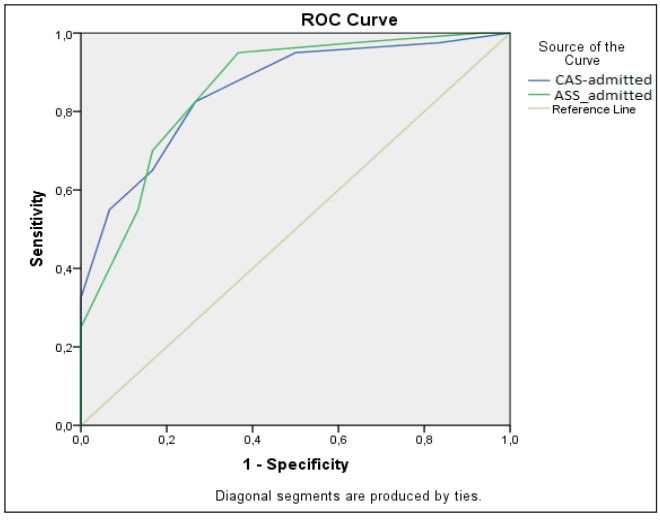

Figure 1. ROC curves for CAS and ASS.
CAS: Clinical asthma score, **ASS:** Asthma severity score.

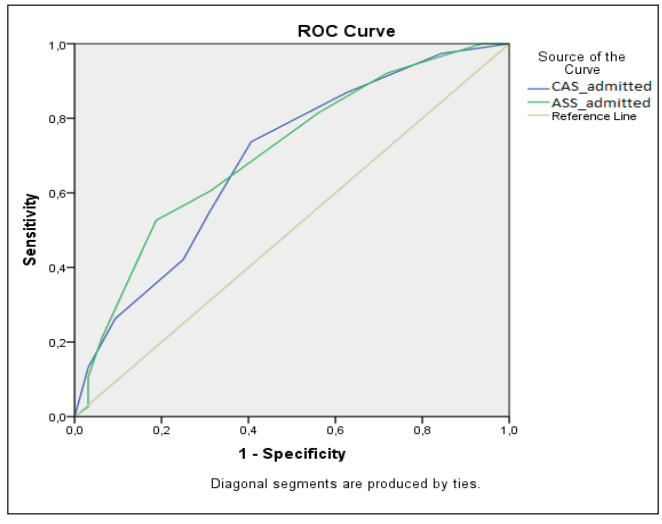

Figure 2. CAS and ASS at admission in systemic steroid therapy.
CAS: Clinical asthma score, **ASS:** Asthma severity score.

Table V: Admitting scores according to frequency of attacks in the last year.

Characteristic*	Patients with ≥3 wheezing attacks in the last year (n=40)	Patients with <3 wheezing attacks in the last year (n=30)	*P*
Presenting CAS	7 (5-9)	5 (4-7)	**0.010**
Presenting ASS	5 (4-7)	4 (3-6)	**0.019**

* Data presented as median (interquartile range).

The patients were also compared based on number of acute wheezing episodes in the last year (≥3 versus 2 exacerbations). Forty (57.1%) patients had three or more and 30 (42.9%) had two episodes within the last year. Comparison of the presenting CAS and ASS showed that patients with three or more episodes within the last year had significantly higher median CAS than those with two episodes (7 [5–9] versus 5 [4–7]; p=0.010). Presenting ASS was also significantly higher in patients with three or more episodes within the last year compared to those with two episodes (5 [4–7] versus 4 [3–6]; p=0.019). Distribution of presenting CAS and ASS according to exacerbation frequency is shown in Table V.

DISCUSSION

This cross-sectional study evaluated asthma scores of preschool patients who presented to a pediatric emergency department with recurrent wheezing. We analyzed correlations between the scoring systems and their role in predicting acute treatment and hospital admission after initial salbutamol therapy. The CAS and ASS scoring systems were significantly correlated and both predicted the use of steroid therapy and hospital admission after exacerbation. This study represents the first comparative study of these two scoring systems in the literature.

Although more than 16 asthma severity scoring systems have been described, they are difficult to evaluate because most have not been compared with standard severity scales or include components which have not been adequately verified (9). A few of these clinical scores were reported in more definitive studies that included reliability, validity, and sensitivity measures (4): CAS, ASS, Preschool Respiratory Assessment Measure (PRAM), Pulmonary Index (PI), and Pulmonary Score (PS).

A 2014 review by Bekhof et al. analyzed 65 studies and compared 36 different asthma scoring systems. The authors concluded that although numerous scoring systems were being used in the evaluation of acute asthma exacerbations, wheezing, and dyspnea severity in exacerbations of bronchiolitis in children 0-18 years of age, none of them alone was significant in clinical use for children with acute dyspnea and wheezing. Accessory muscle use was evaluated in 35 (97%) of the 36 scoring systems, followed by wheezing (n=34, 94%), respiratory rate (n=26, 72%), cyanosis and mental status (n=17, 47%), dyspnea (n=10, 28%), and air entry (n=9, 36%) (10). A 2010 study by Gouin et al. compared the use of PRAM and the Pediatric Asthma Severity Score (PASS) during asthma exacerbations in 283 children aged 18 months to 7 years. In both scoring systems, patients were evaluated at presentation and 90 minutes later, after patients were treated with bronchodilator therapy three times at 20-minute intervals or two times at 30-minute intervals. Their study indicated that both scoring systems were correlated and could be used to assess asthma severity in selected patients (11). In our study, scores decreased significantly between exacerbation presentation and after initial salbutamol treatment, which suggests that these scoring systems can also be used in the follow-up of exacerbation outcomes.

There is conflicting evidence on the role of clinical assessments in predicting the triage and hospital admission. A PRAM score of 8 or higher was reported to have 98% specificity and 50% sensitivity (7). In another study it was reported that a Modified Pulmonary Index Score (MPIS) of 5 or higher had 42.4% sensitivity and 85.3% specificity in predicting admission (12). A PI score of 6 or higher was strongly correlated with admission (13). In the present study, a cut-off of 3.5 for ASS had 95% sensitivity and 63.3% specificity while a CAS threshold of 5.5 had 82.5% sensitivity and 73.3% specificity in the prediction of hospital admission after initial salbutamol therapy. These findings suggest that both scoring systems can be used to determine whether the patient will be discharged or be admitted for inpatient follow-up after an acute episode.

In a study by Bacharier et al. on preschool children with wheezing, it was reported that patients who had an exacerbation that required systemic steroid therapy within

the last year had higher rates of emergency department presentation due to asthma-related symptoms, hospital admission, use of high-dose drugs to control asthma, and aeroallergen sensitivity (14). In our study, there was a significant difference in presenting scores between patients who were treated with systemic steroids during the acute episode and those who were not. Based on ROC curve analysis, a CAS cut-off of 5.5 had 73.7% sensitivity and an ASS cut-off of 5.5 had a sensitivity of 52.6% in the prediction of steroid administration. This suggests that patients with higher scores may require systemic steroid therapy; however, double-blind, placebo-controlled studies with larger patient groups are needed to determine whether systemic steroid therapy is effective.

In our study, patients who had three or more acute episodes within the last year had significantly higher scores at presentation than those who had two episodes. These findings indicate that patients who have high CAS and ASS at time of presentation for acute wheezing exacerbations are at higher risk of more frequent exacerbations.

This is the first study to compare two clinical scoring systems in children with recurrent wheezing in the literature. Our results demonstrate that calculating the clinical scores of the patients at the time of presentation with wheezing exacerbation can provide clues as to which patients can be discharged from the emergency department and which may benefit from longer follow-up, and whether steroid therapy will be necessary.

Conflict of Interest

On behalf of all authors, the corresponding author states that there are no conflicts of interest to declare.

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