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Original Article

Validation of the Paediatric Asthma Score (PAS) in Evaluation of Acute Exacerbation of Asthma in Children

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Abstract

Introduction: Assessing the severity of acute asthma objectively is important to guide treatment. Peak Expiratory Flow Rate (PEFR) is used for this. Paediatric Asthma Score (PAS) is a user-friendly asthma score in children. Our aim was to validate the efficacy of PAS in comparison with PEFR for assessing severity of acute asthma.

Methods: The study included 32 children in the age group of five to 14 years, with mild to moderate asthma exacerbation. The PEFR and the PAS were measured before treatment, 15 min, 30 min, and one hour after treatment, and at discharge. Paired t-test was used to establish construct validity by comparing pre-and post-treatment PEFR and PAS. The criterion validity was calculated by correlating pre-and post-treatment PASs with PEFRs.

Results: The mean predicted PEFR improved with treatment by 22.35% ($p < 0.001$) by one hour. Pre- and post-treatment PASs significantly correlated with PEFRs. The correlation of pre-treatment PEFR and PAS was $r = -0.491$ ($p = 0.004$), that for post-treatment at 1 hour was $r = -0.505$ ($p = 0.003$).

Conclusions: The study validities the PAS as a measure of severity of asthma. The PAS is thus a simple alternative to the PEFR to estimate airway obstruction in children within the age group to five to 14 years with acute asthma exacerbations.

Introduction

Bronchial asthma is a common chronic respiratory disease in children characterised by airway hyper-responsiveness and causing considerable morbidity leading to increased emergency department visits, hospitalizations, and missed school days.[1]

An acute exacerbation of bronchial asthma needs an assessment of severity to decide the treatment, and for measuring response to treatment. Spirometry is the most accurate assessment tool for asthma severity.[2] However, the equipment and personnel required for spirometry is not available in most casualties. The Peak Expiratory Flow Rate (PEFR) is a simpler tool used in the emergency setting to measure the degree of airway obstruction.[3] Both PEFR and spirometry are difficult to perform in children < five years and at any age when there is severe asthma, because they find it difficult to blow forcefully into the device. In such children, the evaluation of the severity of airway obstruction relies on clinical evaluation. This clinical evaluation involves a combination of clinical signs, as there is no single clinical sign that sufficiently correlates with the degree of dyspnoea or narrowing of the airway. There are more than 17 severity scoring systems which use a combination of clinical features and signs.[4] Many of them are complex requiring measurement of blood gases, and hence are not easy to use in the emergency setting and not all are validated.

The Paediatric Asthma Score (PAS) is one such scoring system which however is simple, and easy to measure involving five clinical parameters to assess severity in children with an acute asthma exacerbation.[5] But PAS has yet not been validated. It is possible to use scoring systems that are not validated but the assessment accuracy is not certain. The purpose of this study was to validate the PAS as a measure of airway obstruction in children presenting to the emergency / paediatric department for the treatment of an acute asthma exacerbation by evaluating its efficacy in comparison to the PEFR which is the standard tool used

Methods

Children in the age group of five to 14 years with mild to moderate exacerbation of asthma who presented to our hospital, a tertiary care institution in South India from December 2019 to July 2021 were included in the study by consecutive sampling method. Children who were less than five years, those who had cardiac, neurological, musculoskeletal, immunosuppressive conditions affecting pulmonary function, those who were not able to perform PEFR like children below five years of age and those with severe exacerbation of asthma, and those whose parents did not give written informed consent were excluded from the study. Thirty two children thus selected were assessed with PAS and PEFR simultaneously before starting treatment. PAS comprises five clinical parameters: respiratory rate, oxygen saturation, auscultation findings, presence of retractions, and degree of dyspnoea (Table 1). Based on scoring, severity was graded into mild (≤ 7), moderate (8 - 11) and severe (≥ 12). This study was conducted after the institutional ethical clearance. (Ethical clearance no: 62/19/IEC/JMMC&RI). Based on the correlation coefficient of peak expiratory flow rate (PEFR) and Paediatric Asthma Score (PAS) observed in an earlier publications by Sharon R Smith et al, with 95% confidence level and 90% power minimum sample size comes to 40 -

$$n = \frac{[Z_{1-\alpha/2} + Z_{1-\beta}]^2}{0.5\left[\log \frac{(1+r)}{(1-r)}\right]} + 3$$

In the background of COVID 19 pandemic, admissions with asthma were less (a universal phenomenon seen all over the world, probably a consequence of using masks, closure of schools, social distancing, and home isolation) hence the sample size expected couldn't be achieved. Therefore, in the present study, only 32 cases who presented with acute exacerbations of asthma during the study period were included in the study as per the inclusion criteria.

Table 1: Paediatric Asthma Score[6]

Score	**1**	**2**	**3**
Respiratory rate (per minute)			
2 to 3 years	≤ 34 / min	35 to 39 / min	≥ 40 / min
4 to 5 years	≤ 30 / min	31 to 35 / min	≥ 36 / min
6 to 12 years	≤ 26 / min	27 to 30 / min	≥ 31 / min
> 12 years	≤ 23 / min	24 to 27 / min	≥ 28 / min
Oxygen requirement	> 90% in room air	85 to 90% in room air	< 85% in room air
Auscultation	Normal breath sounds OR End expiratory wheeze only	Expiratory wheezing	Inspiratory and expiratory wheezing or diminished breath sounds
Retractions	≤ one site	2sites	≥ 3 sites
Dyspnoea	Speaks in sentences, coos babbles	Speaks in partial sentences, short cry	Speaks in single words / short phrases / grunting

PEFR was measured by using Peak Flow Meter Scale and the observed PEFR values were expressed as the percentage of normal PEFR which was taken based on height and gender. These children were then managed with standard bronchodilator therapy. They were then reassessed at 15 minutes, 30 minutes and one hour after the first dose of bronchodilator therapy, and during the time of discharge with PEFR and PAS measured simultaneously. Improvement in PEFR values was compared with that of PAS. The construct and the criterion validities of the PAS were evaluated. Construct validity checks the degree to which an instrument (in this case, the PAS) measures the construct (airway obstruction) and criterion validity is the degree to which an instrument (the PAS) correlates with an established criterion (the PEFR values). In our study, construct validity was established by comparing pre and post-treatment PASs and the pre and post-treatment PEFRs and was calculated using paired t test. For measuring criterion validity, negative correlation coefficient between paediatric asthma score and PEFR before and after treatment was established by the Pearson correlation coefficient. To measure the significant improvement in PEFR and PAS score after treatment, paired t-test and analysis of variance were used.

Results

In our study, 32 children were evaluated with PEFR and PAS. There was a significant improvement in airway obstruction reflected as a decrease in PAS and an increase in PEFR. The study showed an improvement in mean predicted PEFR by 22.35 percentage points from 49.65% to 72% ($p < 0.001$) by one hour and the mean PAS had improved by 3.5 ($p < 0.001$) from 10.09 to 6.53 by one hour after theraThere was a significant negative correlation between PAS and before and after treatment. There was a significant negative correlation between PAS and PEFR. The correlation of pre-treatment PEFR and PAS was r = - 0.491 (p = 0.004), that for post treatment at 15 minutes was r = -0.281 (p = 0.120), at 30 minutes was r = -0.432 (p = 0.013) and at one hour was r = - 0.505 (p = 0.003). Thus, the PAS passed both the construct validity test and the criterion validity test.

Table 2: Mean PEFR and PAS

	Mean predicted PEFR					PAS				
	BT	15 min AT	30 min AT	1 Hour AT	At DISC	BT	15 min AT	30 min AT	1 Hour AT	At DISC
MEAN	49.65	56.19	60.68	72	86.75	10.09	9.50	8.28	6.53	2

[BT – Before treatment; AT – After treatment; MIN- minutes; AT DISC - at the time of discharge]

Discussion

Both tests of validity were passed by the PAS. The construct validity test measuring the degree to which the PAS measures airway obstruction was done by measuring the pre and post treatment PAS scores to the PEFR scores, the latter being a standard method for measuring airway obstruction. Pulmonary Function Tests (PFT) using spirometry provide the best assessment of asthma severity but since they are impractical in the emergency setting due to the lack of equipment and trained personnel available in the casualty for interpretation of the PFT, the PEFR which is the test used in the emergency setting to measure airway obstruction was used as the established criterion for testing validity in our study. Studies validating other asthma scores have also used the PEFR as the established criterion.[7]

There is a significant improvement of PEFR with treatment from 49.65% to 72% ($p < 0.001$) by one hour, which indicates a reduction of bronchial obstruction. This reduction should be reflected by a decrease in the PAS score for the PAS to be valid. The PAS had improved (decreased) after treatment from 10.09 to 6.53 ($p < 0.001$). This establishes the construct validity of the PAS. The criterion validity tested using the PEFR as the established, standard measure of airway obstruction showed a significant correlation both

Ours is the first study to validate the Paediatric Asthma Score. The correlation between PEFR and PAS in our study ranged from r = -0.491 (pre-treatment) to r = -0.505 (post-treatment) and these findings are like those in studies validating other asthma scores with other measures of pulmonary function. In a similar study by Yung M et al, the asthma severity score (ASS) correlated with oxygen saturation (r = -0.45) and FEV1 (r = - 0.54).[8] In a study by Kerem E et al, the clinical severity score (CSS) was compared with arterial oxygen saturation and FEV1, with correlations of r = 0.49 and r = 0.52.[7] In a study by Sharon R Smith et al, the PEFR and Pulmonary Score correlations for the nursing-obtained scores were pre-treatment r = -0.57 and post-treatment r = -0.67 and for the physician-obtained scores were pre-treatment r = -0.44 and post-treatment r = -0.56[6]. In a study by Gorelick M H et al, to evaluate Paediatric Asthma Severity Score and PEFR and pulse oximetry, a significant correlation between PASS and PEFR (r = 0.27 to 0.37) and pulse oximetry (r = 0.29 to 0.41) at various time points was noticed.[10] Scoring systems are not perfect as they are based only on clinical signs, and not on actual estimation of bronchial obstruction.[11] But in situations like in children too young or too ill to perform a measure of bronchial obstruction, the PAS which is both easy to use, and is reasonably accurate can serve as an acceptable substitute both for assessing severity and for monitoring response to treatment. The Paediatric Asthma Score was compared with the Peak Expiratory Flow Rate which is a substitute for complex pulmonary function tests like spirometry. It is difficult to perform an expiratory manoeuvre like PEFR in a sick child with severe airway obstruction and in children below five years, so they had to be excluded. Even though we included all children who satisfied the inclusion criteria who were admitted to our hospital during the study period, the total number of cases was less, due to the general decrease in asthma in children during the COVID pandemic. This is a relatively small study conducted in a single study. We can't deny that biases could have been there and the results may not be possible to generalize in all the children. Hence, it is expected that the results of this should be validated in more elaborate and larger multi centric prospective and randomized trials.

Conclusions

Paediatric Asthma Score is an easy and suitable method for assessing the degree of airway obstruction. The validities of PAS were established by construct validity of the PAS through correlation of the pre-and post-treatment scores, and criterion validity by the correlation between the PAS and the PEFR. Hence, the PAS can be used to evaluate the degree of airway obstruction and can be used instead of the PEFR to evaluate response and guide therapy in those asthmatic children who are too sick or too young to perform expiratory manoeuvres.

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