

Asthma Control Assessment in Children: Correlation between Asthma Control Test and Peak Expiratory Flow

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ABSTRACT

Objectives: To assess the correlation between asthma control test and peak expiratory flow measurements in children and the impact of certain factors influencing asthma symptoms perception over their correlation.

Methods: A prospective study including 54 patients aged 5 to 18 years old, who have been diagnosed with asthma in „Victor Gomoiu” Children’s Clinical Hospital between May 2012-November 2013, was initiated. For each patient a personalized asthma monitoring plan was designed. This presumes many evaluations assigned to assess the asthma control status. These evaluations consist in counting of asthma symptoms using ACT (Asthma Control Test) and evaluation of pulmonary function using PEF measurement (peak expiratory flow) and spirometry. In each patient factors known to have an influence on asthma symptoms perception (small age, overweighting and allergic rhinitis) were searched. Finally, the correlation between ACT value and PEF variation and how this correlation is influenced by these factors were assessed.

Results: From all 54 included patients a total of 113 evaluations moments were recorded. The assessment of correlation between ACT score and PEF variation for all evaluations showed a strong correlation overall ($p < 0.01$). The correlation is stronger in the small age group (5 to 6 years: $p < 0.01$) than in the older age group (6 to 11 years: $p = 0.014$, > 12 years: $p = 0.03$). ACT does not correlate with PEF variation in the overweight patients subgroup ($p = 0.226$). We found the percent of overweight equal to 8.57% in the small age subgroup (5 to 6 years), 26.78% in the 6 to 11 years old group and 31.81% in the over 12 years old patient group. ACT is correlated with PEF variation in both the allergic rhinitis and non allergic rhinitis subgroups ($p < 0.01$).

Conclusions: ACT is correlated with PEF variation overall. Their correlation is not influenced by small age and the presence of allergic rhinitis, but is influenced by overweighting.

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INTRODUCTION

Asthma is the most common chronic disease in the childhood period. It is a very heterogeneous disease characterized by chronic airways inflammation and bronchial hyper-responsiveness (1).

From the clinical point of view asthma is characterized by wheezing, cough, shortness of breath and chest tightness. All of them are related to airflow limitation. Together they vary in time and intensity according to specific triggers exposure and to asthma control status achieved through specific controller medication (1).

The goals of asthma management are to achieve good control of symptoms and maintain normal activity levels and to minimize the future risk of exacerbations, fixed airflow limitation and treatment side effects (1).

The key for an efficient asthma management is an accurate asthma control assessment (1).

Usually asthma control status is assessed through the count of asthma related symptoms and the use of reliever medication for relief of the symptoms (1).

The count of asthma related symptoms refers to a self evaluation of asthma symptoms (cough, wheezing, limitation of activity, night waking do to asthma) in the past four weeks. This "numerical asthma control tool" provides scores that distinguish between different levels of asthma control (1).

Among these "numerical asthma control tools" is Asthma Control Test. Asthma Control Test (ACT) is a widely used asthma control assessment tool that is recognized by the Global Strategy for Asthma Management and Prevention, Global Initiative for Asthma (GINA), as a tool for asthma symptoms control assessment (1).

ACT has two versions: one for 4 to 11 years patients and one for over 12 years old patients. ACT is performed by each patient alone (if the patient is >12 years old) or both by the patient (using a visual analogue scale) and their parents (if the patient is 4 to 11 years old) (1).

As a result this assessment is very subjective because the perception of the symptoms is submitted to an amount of subjectivity that is very difficult to be completely estimated (2-4). Moreover also the need for reliever medication

is related to the perception of asthma symptoms.

Along the years many studies signalized the influence of specific factors on asthma symptoms perception and, by that, on asthma control assessment.

Obesity can influence asthma symptoms perception because many of the respiratory symptoms associated with obesity can mimic asthma; furthermore many obese patients tend to have a sedentary lifestyle impairing an accurate perception of activity limitation (1, 5-7).

Allergic rhinitis is often a companion for asthma (is believed that nearly 80% of asthmatic children have allergic rhinitis) and often, among children, the bothersome respiratory symptoms related to allergic rhinitis might be confused with asthma symptoms and vice versa (8).

The age of the patient is another factor that can influence the perception of asthma symptoms; the smaller is the age, it becomes more difficult to provide a objective evaluation of specific symptoms, both by the patients and by their parents (9-11).

Moreover the smaller is the age, it becomes more difficult to find an exact correspondent for each symptom on a visual analogue scale, the way is provided by the ACT for children aged 4 to 11 years old (12).

For those reasons there is a need for an objective assessment of airflow limitation between the medical evaluation visits.

Peak expiratory flow measurement is a simple tool, designed for individual, at home use, that provides a picture of the variation in airflow limitation and, by that, of asthma control status.

The peak expiratory flow rate (PEFR or simply peak expiratory flow, PEF) represents the maximal rate that a person can exhale during a short maximal expiratory effort after a full inspiration (13).

The normal PEF values varies for each individual and are calculated based on the baseline values, recorded daily for two weeks, when the patient is asymptomatic and after a period of maximal asthma control therapy. Those values are used to define the "personal best" PEFR value for that particular patient; this value must be reevaluated annually to account for growth in children and disease progression.

That value is the highest PEFR measurement recorded during this period. The patient's nor-

mal PEF range is defined as 80 and 100 percent of the patient's personal best (14).

Any value below this normal range indicates airflow limitation, which can occur prior to the onset of symptoms.

PEF values are mainly used as PEF values variation and there are many alternatives for calculating the PEF value variation (15).

Short-term PEF monitoring is recommended following an exacerbation or a change in treatment, if the symptoms appear excessive or to assist the triggers identification (13).

Long-term PEF monitoring is recommended for early detection of exacerbations mainly in patients with poor perception of symptoms, in patients with sudden severe exacerbations or in patients with difficult to control or severe asthma (1).

Owing to the fact that ACT score is influenced by the perception of symptoms and PEF monitoring is recommended for patients with poor asthma symptoms perception, the objective of this study is to assess the correlation between ACT and PEF measurements in children. In other words the objective of this study is to assess the impact of certain factors influencing asthma symptoms perception, like overweighting, small age and allergic rhinitis, on ACT score, impact reflected by the correlation between ACT score and PEF variation. □

METHODS

A prospective study including 54 children aged 5 to 18 years, who have been diagnosed with asthma in „Victor Gomoiu” Children's Clinical Hospital between May 2012-November 2013, has been initiated.

Inclusion criteria were:

1. age between 5 and 18 years;
2. asthma diagnosis established using specific criteria of history, clinical exam and spirometry parameters; diagnosis was confirmed by proving FEV1 reversibility of at least 12% after salbutamol inhalation (1).

Exclusion criteria: other coexistent comorbidities beside allergic rhinitis and overweighting.

In the first stage, for each included patient, an asthma action plan has been drawn, which contains personalized prescriptions and recommendations addressed to the control of triggers and to the use of reliever medication.

An appropriate controller treatment was prescribed for each patient with persistent asthma.

Next an individualized asthma monitoring plan was designed, following the recommendations from Global Strategy for Asthma Management and Prevention, Global Initiative for Asthma (GINA) (1), which included:

1. ACT and spirometry assessment:

- at one week, one month, 3 months and 6 months since the beginning of controller therapy;
- at 2 weeks, one month, 3 months and 6 months since the controller therapy adjustment (step-up or step-down);
- when any exacerbation occur.

ACT score was established using an age appropriate questionnaire: the questionnaire for children 4 to 11 years was filled by both the patient and his parents, while the questionnaire for children over 12 years was filled only by the patient.

Spirometry results were not used for the statistical analyze in this study.

2. PEF monitoring in the first 2-4 weeks:

- since beginning the controller therapy to assess treatment response;
- since initiating a controller therapy adjustment (step-up or step-down) to confirm the controller asthma status maintenance (controlled asthma status is defined by ACT score >19, FEV1 >80% from predicted value and reliever medication use less than twice a week in the last 4 weeks) (1);
- 2 weeks after an exacerbation occur.

For PEF measurement we have used Mini-Wright Peak Flow Meter, a device appropriate for childhood use (16).

PEF was measured by each patient twice daily (in the morning, soon after waking-up, and in the evening), each time undergoing three attempts and recording the highest value. The “personal best” PEF value for each patient was defined using PEF recordings from the first two monitoring weeks. That value is the highest PEF measurement recorded during this period. The patient's normal PEF range is defined as 80-100% of the patient's personal best (14).

For each evaluation moment and for each patient were recorded:

1. date of birth, age and sex; three age subgroups were defined: 5-6 years, 6-11 years and >12 years. The small age group (5 to 6 years) was separately defined do to the uncertainties

still existent among different experts regarding the precision of asthma diagnosis at this age; these uncertainties arise from the variable ability of small children to perform reproducible expiratory maneuvers (1).

2. weight and height; using body mass index (BMI) calculator we have established if the patient is normal weight or overweight (17); there was no patient underweight.

3. ACT score was recorded as ≤ 19 (not controlled) or > 19 (normal, controlled).

4. PEF variability in the last 2 weeks before the evaluation; PEF variability was estimated for each week by calculating how much in percent represents the lowest value of the week from the highest value of that week; a lowest PEF value $> 80\%$ from the highest PEF value of the week was considered normal (PEF variation $\leq 20\%$) and a lowest PEF value $\leq 80\%$ from the highest PEF value of the week was considered increased (PEF variation $> 20\%$) (15).

5. allergic rhinitis diagnosis established using specific history and clinical features (paroxysms of sneezing, rhinorrhea, nasal obstruction, nasal itching, postnasal drip, cough, irritability, and fatigue related to specific triggers exposure) (18).

Only the evaluations that included both ACT score and PEF variation were considered for this study. A total of 113 distinct evaluations were recorded for all included patients. $\square$

RESULTS

From those 113 evaluations in 70 evaluations PEF variation was normal ($\leq 20\%$) and in 43 of them was increased ($> 20\%$); in 72 of them ACT score was normal (> 19) and in 41 of them was decreased (≤ 19) the way is depicted in Table 1.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score resulted a value of $p < 0.01$ (highly statistically significant).

Among included patients 15 patients were in the 5 to 6 years subgroup, 29 patients in the 6 to 11 years subgroup and 10 patients in the > 12 years subgroup.

In 5 to 6 years subgroup 35 evaluations were recorded; in 26 of them PEF variation was normal ($\leq 20\%$) and in 9 of them was increased ($> 20\%$); in 22 of them ACT score was normal (> 19) and in 13 of them was decreased (≤ 19) the way is depicted in Table 2.

PEF/ACT	≤ 19	> 19	TOTAL
$> 20\%$	29	14	43
$\leq 20\%$	12	58	70
TOTAL	41	72	113

TABLE 1. Correlation between PEF variation and ACT score.

PEF/ACT	≤ 19	> 19	TOTAL
$> 20\%$	9	0	9
$\leq 20\%$	4	22	26
TOTAL	13	22	35

TABLE 2. Correlation between PEF variation and ACT score in 5 to 6 years subgroup.

PEF/ACT	≤ 19	> 19	TOTAL
$> 20\%$	11	12	23
$\leq 20\%$	5	28	33
TOTAL	16	40	56

TABLE 3. Correlation between PEF variation and ACT score in 6 to 11 years subgroup.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score in 5 to 6 years subgroup resulted a value of $p < 0.01$ (highly statistically significant).

In 6 to 11 years subgroup 56 evaluations were recorded; in 33 of them PEF variation was normal ($\leq 20\%$) and in 23 of them was increased ($> 20\%$); in 40 of them ACT score was normal (> 19) and in 16 of them was decreased (≤ 19) the way is depicted in Table 3.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score in 6 to 11 years subgroup resulted a value of $p = 0.014$ (statistically significant).

In > 12 years subgroup 22 evaluations were recorded; in 11 of them PEF variation was normal ($\leq 20\%$) and in 11 of them was increased ($> 20\%$); in 10 of them ACT score was normal (> 19) and in 12 of them was decreased (≤ 19) the way is depicted in Table 4.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score in > 12 years subgroup resulted a value of $p = 0.03$ (statistically significant).

Regarding the BMI in the 5 to 6 years subgroup 8.57% patients were overweight, in the 6 to 11 years subgroup 26.78% patients were overweight and in > 12 years subgroup 31.81% patients were overweight.

In overweight subgroup 25 evaluations were recorded: in 12 of them PEF variation was normal ($\leq 20\%$) and in 13 of them was increased ($> 20\%$); in 15 of them ACT score was normal (> 19) and in 10 of them was decreased (≤ 19) the way is depicted in Table 5.

PEF/ACT	≤19	>19	TOTAL
>20%	9	2	11
≤20%	3	8	11
TOTAL	12	10	22

TABLE 4. Correlation between PEF variation and ACT score in >12 years subgroup.

PEF/ACT	≤19	>19	TOTAL
>20%	7	6	13
≤20%	3	9	12
TOTAL	10	15	25

TABLE 5. Correlation between PEF variation and ACT score in overweight subgroup.

PEF/ACT	≤19	>19	TOTAL
>20%	22	8	30
≤20%	9	49	58
TOTAL	31	57	88

TABLE 6. Correlation between PEF variation and ACT score in normal weight subgroup.

PEF/ACT	≤19	>19	TOTAL
>20%	17	7	24
≤20%	6	26	32
TOTAL	23	33	56

TABLE 7. Correlation between PEF variation and ACT score in allergic rhinitis subgroup.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score in overweight subgroup resulted a value of $p=0.226$ (not statistically significant, $p>0.05$).

In normal weight subgroup 88 evaluations were recorded: in 58 of them PEF variation was normal ($\leq 20\%$) and in 30 of them was increased ($>20\%$); in 57 of them ACT score was normal (>19) and in 31 of them was decreased (≤ 19) the way is depicted in Table 6.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score in normal weight subgroup resulted a value of $p<0.01$ (highly statistically significant).

Regarding the allergic rhinitis diagnosis 32 patients (59.26%) had allergic rhinitis among included patients.

In allergic rhinitis subgroup 56 evaluations were recorded: in 32 of them PEF variation was normal ($\leq 20\%$) and in 24 of them was increased ($>20\%$); in 33 of them ACT score was normal (>19) and in 23 of them was decreased (≤ 19) the way is depicted in Table 7.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score in allergic rhinitis subgroup resulted a value of $p<0.01$ (highly statistically significant).

In non allergic rhinitis subgroup 57 evaluations were recorded: in 38 of them PEF varia-

tion was normal ($\leq 20\%$) and in 19 of them was increased ($>20\%$); in 39 of them ACT score was normal ($>19\%$) and in 18 of them was decreased (≤ 19) the way is depicted in Table 8.

Using the Chi-Square Test statistical function to assess the correlation between PEF variation and ACT score in non allergic rhinitis subgroup resulted a value of $p<0.01$ (highly statistically significant). $\square$

DISCUSSIONS

ACT score is correlated with PEF variation overall and also in each age subgroup individually. ACT score is not correlated with PEF variation in the overweight patients ($p=0.226$) probably because in their case the overweight influences asthma symptoms perception enough to have a consistent impact on ACT-PEF correlation.

The correlation between ACT score and PEF variation is the strongest in the 5 to 6 years subgroup ($p<0.01$), less strong in the 6 to 11 years subgroup ($p=0.014$) and lesser in >12 years subgroup ($p=0.03$). This occurs probably because of different percentages of overweight in the three groups, respectively 8.57%, 26.78% and 31.81%. As showed before, overweight influences asthma symptoms perception and, by that, the correlation between ACT score and PEF variation in the overweight subgroup. The strength of statistical correlation between ACT score and PEF variation is different for each age subgroup because their correlation has an inverse ratio relation with overweight percent in each subgroup (the less the overweight children are, the stronger is the correlation between ACT score and PEF variation in that age subgroup).

ACT score is correlated with PEF variation regardless the simultaneous presence of allergic rhinitis. $\square$

CONCLUSIONS

ACT score is overall correlated with PEF variation. The correlation between ACT score and PEF variation is not influenced by the presence of allergic rhinitis or by the small age of the patient.

ACT score is not correlated with PEF value in overweight patients. In this case both clinical and PEF monitoring at home, between medical evaluations, can be much helpful than a clinical monitoring alone.

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