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Patient and physician evaluation of the severity of acute asthma exacerbations

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Abstract

We studied the ability of patients not experienced in the use of peak expiratory flow meters to assess the severity of their asthma exacerbations and compared it to the assessment of experienced clinicians. We also evaluated which data of physical examination and medical history are used by physicians to subjectively evaluate the severity of asthma attacks. Fifty-seven adult patients (15 men and 42 women, with a mean (± SD) age of 37.3 ± 14.5 years and 24.0 ± 17.9 years of asthma symptoms) with asthma exacerbations were evaluated in a University Hospital Emergency Department. Patients and physicians independently evaluated the severity of the asthma attack using a linear scale. Patient score, physician score and forced expiratory volume at the first second (FEV_1) were correlated with history and physical examination variables, and were also considered as dependent variables in multiple linear regression models. FEV_1 correlated significantly with the physician score (rho = 0.42, P = 0.001), but not with patient score (rho = 0.03; P = 0.77). Use of neck accessory muscles, expiratory time and wheezing intensity were the explanatory variables in the FEV_1 regression model and were also present in the physician score model. We conclude that physicians evaluate asthma exacerbation severity better than patients and that physician's scoring of asthma severity correlated significantly with objective measures of airway obstruction (FEV_1). Some variables (the use of neck accessory muscles, expiratory time and wheezing intensity) persisted as explanatory variables in physician score and FEV_1 regression models, and should be emphasized in medical schools and emergency settings.

Key words
- Asthma
- Asthma attack
- Pulmonary function tests
- Dyspnea

Introduction

Asthma is a chronic airway inflammatory disease characterized by symptoms of wheezing, chest tightness and breathlessness (1). Patients with asthma also present episodic airway obstruction. In the presence of an acute exacerbation of asthma, the physician must know the severity of airway obstruction in order to provide appropriate therapy and to identify life-threatening episodes.

In the emergency room, physicians usually assess the severity of airway obstruction using symptoms and physical signs such as respiratory distress, wheezing, contraction of accessory respiratory muscles, the presence of pulsus paradoxus, tachycardia, and tachypnea. However, it has been suggested that physical findings are not reliable indicators of the severity of airway obstruction (2). Kelsen et al. (3) observed, in an emergency room, that measured airway obstruction was only modestly increased when patients had sufficiently improved to be discharged using clinical criteria (3). A clinically significant proportion of asthmatic patients substantially underestimate disease severity and thereby may be at risk of increased morbidity and mortality (4).

Current recommendations are that an objective measure of airway obstruction such as forced expiratory volume (FEV_1) or peak expiratory flow rate (PEFR) should be used, in addition to symptoms and physical findings, in the initial evaluation and assessment of adequacy of treatment of asthma exacerbations in the emergency room (5).

The ability of patients to detect the severity of their own asthma exacerbation has been less well studied. Shim and Williams Jr. (6) observed that patients experienced in the use of peak flow meters were more accurate in estimating their own PEFR than experienced physicians. However, a substantial number of patients with asthma do not use peak flow meters regularly. We reasoned that patient assessment of the severity of asthma exacerbation would add relevant information to the evaluation of acute airway obstruction.

The purposes of the present investigation were to determine the ability of patients not experienced in peak flow meter use to assess the severity of their own asthma exacerbations and to compare this to the assessment of experienced clinicians, using FEV_1 as the gold standard of measurement of the severity of airway obstruction. We also evaluated which data of the physical examination and medical history are used by doctors to subjectively evaluate the severity of asthma attacks.

Subjects and Methods

The Research Ethics Committee of the School of Medicine, University of São Paulo, approved our protocol. All patients gave written informed consent to participate in the study.

Subjects

We studied 57 patients (15 men and 42 women) admitted to the emergency room of the Hospital das Clínicas, University of São Paulo, with an acute attack of asthma, over a period of 18 months. Patient mean (± SD) age was 37.3 ± 14.5 years (range: 16-72 years). All patients had a history of asthma (24.0 ± 17.9 years of symptoms). The criteria for inclusion in the study were: 1) past history of asthma, diagnosed according to American Thoracic Society (7) criteria and previous doctor diagnosis of asthma; 2) absence of symptoms suggestive of chronic bronchitis or chronic obstructive pulmonary disease, such as chronic cough; 3) no previous experience in the use of peak flow meters; 4) age range from 16 to 70 years; 5) initial FEV_1 lower than 80% of predicted and FEV_1/forced vital capacity lower than 80%.

We also excluded patients whose symptoms had developed after years of cigarette smoking or who could not perform the spirometric maneuvers, either due to intense dyspnea or to lack of understanding of the spirometric maneuvers. Only 19.3% of the patients had used corticosteroids during the present crisis before admission to the hospital.

After being asked questions by the researchers to ascertain the asthma diagnosis and to exclude other causes of airway obstruction, the patient was submitted to spirometry, the history was taken and physical examination was performed. The same person performed all the spirometric studies, and physicians with at least 10 years of clinical experience did the medical evaluation. Neither the physicians nor the patients were aware of the spirometric results. The patients were medicated according to the routine of the service.

History variables

The background information asked was duration of asthma, occupational exposure, hospital admissions in the previous year, previous intensive care unit admissions, previous mechanical ventilation due to asthma crisis, cigarette smoking status, use of inhaled or oral steroids, and duration of the present asthma attack. The symptoms elicited were coughing, presence of pulmonary secretion, thoracic pain or discomfort, and intensity of dyspnea sensation. When the history was completed, patients were asked to grade the severity of their attack on a linear scale, with the worst possible scenario at the left end and the best possible at the right end ("patient score"), adapted from Borg's scale of breathlessness (8).

Physical examination variables

The variables studied were pulse, systolic and diastolic blood pressure, pulsus paradoxus, respiratory frequency, expiratory time and forced expiratory time (in seconds, measured with a chronometer, mean of three measures), use of neck accessory muscles, presence of intercostal retraction, nares flaring, cyanosis, intensity of breath sounds, wheezing, wheezing in forced expiration, and presence of rhonchi. At the end of the physical examination the physician graded the severity of the asthma exacerbation using another linear scale, identical to the one used by patients ("physician score"). The physician who did the clinical evaluation and graded the severity of the asthma attack was unaware of the patient self-evaluation.

Spirometry

The same person performed all the spirometric studies, according to American Thoracic Society standardization (9), using a portable Koko spirometer and software (Pds Instrumentation, Inc., Louisville, CO, USA).

Statistical analysis

We calculated the pair-wise Spearman correlation coefficients (rank order coefficient, rho) for nonparametric values between the physician score and the variables in the study (both history and physical examination). We also calculated Spearman correlation coefficients for the patient score and the FEV_1. The physician score, the patient score and FEV_1 were considered to be dependent variables in multiple linear regression models, using a stepwise forward procedure, with the explanatory variables (history and physical examination for the physician or just history for the patient and just physical examination for the FEV_1) added one by one, according to their correlation coefficient values (down from the highest). At each step a new variable was added to the model if the P value related to its coefficient was less than 0.10, the P values of the previous variables did not rise above 0.10, and this variable increased the model adjusted R square. We also tested the possible interactions between significant explanatory variables.

Results

The present asthma exacerbation lasted 79.0 ± 125.1 h (range 1-720 h). FEV_1 values were 40.3 ± 17.0% (range 22.0-75.0%) and peak expiratory flow values were 33.0 + 14.0% (range 19.0-75.5%).

Table 1 shows the Spearman correlation coefficients (rho) between all the variables studied and physician score (from 0 to 10), patient score (from 0 to 10) and FEV_1 (% of predicted). The physician score correlated well with FEV_1, with a rho of 0.42 ($P = 0.001$; Figure 1A), and the patient score,

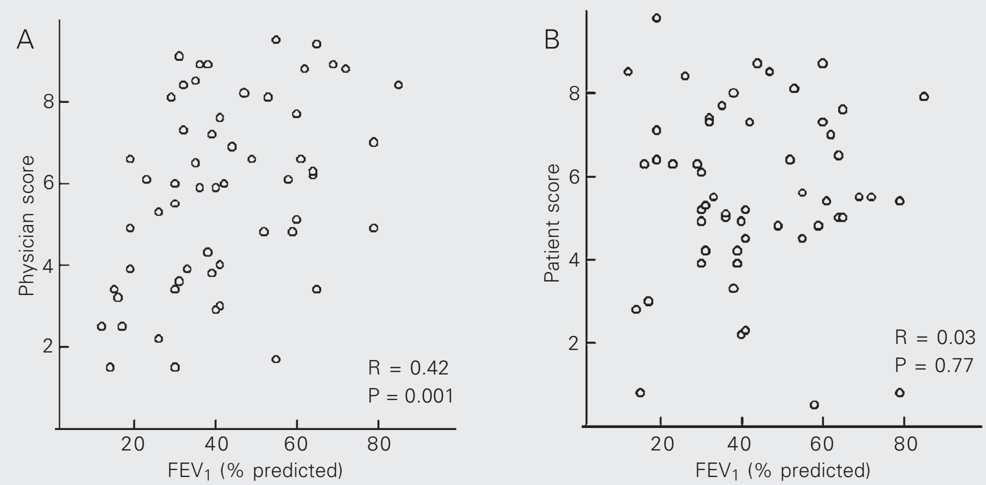

Figure 1. Relationship between severity scores of asthma exacerbation evaluated by physicians (A) and patients (B) and forced expiratory volume at the first second (FEV_1; % predicted). Scores range from 0 (more severe) to 10 (less severe). The correlation coefficients, determined by the Spearman method, were 0.42 for physician score (P = 0.001) and 0.03 for patient score (P = 0.77).

Table 1. Correlation coefficients between physician score, patient score, forced expiratory volume at the first second (FEV_1), and clinical variables.

	Physician score	Patient score	FEV_1 (% predicted)
Physician score	–	0.39*	0.42**
Patient score	0.39**	–	0.04
Use of neck accessory muscles	-0.47**	-0.17	-0.44**
Expiratory time	-0.44**	-0.33*	-0.29*
Dyspnea	-0.42**	-0.45**	-0.13
Previous year hospital admissions	-0.41**	-0.10	-0.16
Pulsus paradoxus >10 mmHg	-0.39**	-0.06	-0.27*
Wheezing	-0.31*	-0.11	-0.44**
Intercostal retraction	-0.31*	-0.19	-0.15
Previous mechanical ventilation	-0.31*	-0.15	-0.11
Vesicular sounds	-0.29*	-0.05	0.00
Nares flaring	-0.27*	-0.30*	0.04
Use of steroids	-0.25	-0.18	0.05
Diastolic blood pressure	-0.25	-0.20	-0.23
Duration of asthma	0.24	0.06	0.15
Cyanosis	-0.23	-0.28*	-0.07
Systolic blood pressure	-0.20	-0.09	-0.18
ICU admissions	-0.19	-0.05	-0.05
Pulse	-0.18	-0.24	-0.20
Cigarette smoking	-0.16	-0.05	-0.21
Forced expiratory time	0.16	0.07	-0.03
Ronchi	-0.14	-0.14	-0.02
Cough	0.13	0.00	0.23
Respiratory frequency	-0.11	0.15	-0.16
Gender	-0.11	0.15	0.06
Wheezing in forced expiration	-0.10	0.07	-0.31
Age	-0.07	0.05	0.05
Thoracic pain	0.04	-0.19	-0.04
Secretion	0.04	0.21	-0.05
Occupational exposure	-0.01	-0.24	-0.02

ICU = intensive care unit. *P < 0.05 and **P < 0.01, obtained by the Spearman method.

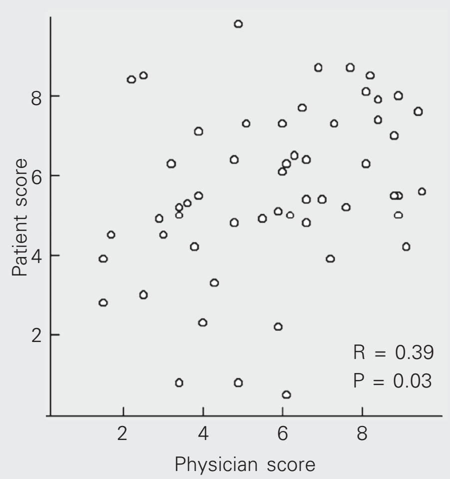

Figure 2. Relationship between severity scores of asthma exacerbation given by physicians and patients. Scores range from 0 (more severe) to 10 (less severe). The correlation coefficient, determined by the Spearman method, was 0.39 (P = 0.03).

although correlating with the physician score (rho = 0.39, P = 0.03; Figure 2), did not correlate with FEV_1 (rho = 0.03, P = 0.77; Figure 1B). The variables with a significant correlation coefficient in relation to the patient score were use of neck accessory muscles, expiratory time, intensity of dyspnea, hospital admissions in the preceding year, pulsus paradoxus higher than 10 mmHg, intensity of wheezing, intercostal retractions, history of need for mechanical ventilation due to asthma attacks, intensity of vesicular sounds, and nares flaring.

Table 2 presents the history and physical examination variables in relation to the patient score, with their descriptive measures (mean, standard error and number of patients in each category). In one patient it was not possible to evaluate the presence of pulsus paradoxus for technical reasons.

When we did a stepwise regression analysis using physician score as the dependent variable, use of neck accessory muscles, expiratory time, hospital admissions in the previous year, pulsus paradoxus, wheezing, and nares flaring remained in the model, with an adjusted R^2 of 0.53 (Table 3).

Table 2. Categorical variables obtained in medical history and physical examination and physician score.

	Mean score	Standard deviation	Number of patients
Use of neck accessory muscles			
No	6.52	2.02	40
Yes	4.10	2.00	17
Previous year hospital admissions			
No	6.54	2.20	35
Yes	4.62	1.93	22
Pulsus paradoxus			
No	6.30	2.07	44
Yes	4.08	2.29	13
Wheezing			
Absent/little	6.83	2.38	17
Moderate/intense	5.36	2.12	40
Nares flaring			
No	5.96	2.26	53
Yes	3.60	1.73	4
Dyspnea			
Absent/little	7.10	1.89	21
Moderate/severe	5.10	2.23	36
Intercostal retraction			
No	6.19	2.25	45
Yes	4.33	1.83	12
Previous mechanical ventilation			
No	6.01	2.24	50
Yes	3.96	1.87	7
Vesicular sounds			
Normal	6.36	2.25	32
Diminished	5.08	2.18	25
Use of steroids			
No	6.08	2.31	46
Yes	4.63	1.81	11
Cyanosis			
No	6.01	2.28	44
Yes	4.86	2.12	13
ICU admissions			
No	5.92	2.29	52
Yes	4.46	2.03	5
Cigarette smoking			
No	6.16	2.41	30
Yes	5.40	2.12	27
Ronchi			
No	5.98	2.46	39
Yes	5.40	1.86	18
Cough			
No	5.53	2.12	26
Yes	6.07	2.46	31
Gender			
Male	6.25	2.06	15
Female	5.64	2.37	42
Wheezing in forced expiration			
Absent/little	6.17	2.45	15
Moderate/intense	5.66	2.24	42
Thoracic pain			
No	5.65	2.41	15
Yes	5.88	2.29	42
Secretion			
No	5.64	2.38	17
Yes	5.90	2.30	40
Occupational exposure			
No	5.81	2.29	40
Yes	5.77	2.36	17

ICU = intensive care unit.

Table 3. Final stepwise regression models using physician score, patient score, and forced expiratory volume at the first second (FEV_1) as dependent variables.

	Coefficient	Standard error	P value	Adjusted R square
Physician score (0-10)				
Use of accessory neck muscles	-1.66	0.51	0.002	0.22
Expiratory time	-0.69	0.39	0.078	0.36
Previous year hospital admissions	-1.42	0.48	0.005	0.44
Pulsus paradoxus >10 mmHg	-1.15	0.53	0.034	0.47
Wheezing	-1.09	0.49	0.031	0.50
Nares flaring	-1.76	0.84	0.040	0.53
Patient score (0-10)				
Dyspnea	-1.98	0.59	0.001	0.16
FEV_1 (% predicted)				
Use of accessory neck muscles	-10.20	4.86	0.041	0.15
Wheezing	-14.94	4.89	0.004	0.26
Expiratory time	-6.58	3.48	0.062	0.28

Table 4. History concerning categorical variables and patient score.

	Mean score	Standard deviation	Number of patients
Dyspnea			
Absent/little	6.85	1.49	21
Moderate/severe	4.87	2.36	36
Previous year hospital admissions			
No	5.69	2.38	35
Yes	5.42	2.12	22
Previous mechanical ventilation			
No	5.66	2.35	50
Yes	5.09	1.68	7
Use of steroids			
No	5.71	2.46	46
Yes	5.08	1.14	11
ICU admissions			
No	5.59	2.33	52
Yes	5.54	1.69	5
Cigarette smoking			
No	5.66	2.40	30
Yes	5.52	2.15	27
Cough			
No	5.69	1.99	26
Yes	5.47	2.55	31
Gender			
Male	5.07	2.09	15
Female	5.77	2.33	42
Thoracic pain			
No	6.33	1.58	15
Yes	5.30	2.46	42
Secretion			
Absent	5.09	2.11	17
Present	5.79	2.36	40
Occupational exposure			
No	5.92	2.35	40
Yes	4.81	1.90	17

ICU = intensive care unit.

Table 4 shows the descriptive measures of history categoric variables in relation to patient score. Although some variables correlated with patient score (dyspnea, expiratory time, nares flaring, and cyanosis), only dyspnea persisted in the stepwise regression analysis, with an adjusted R^2 of 0.16 (Table 3).

Table 5 shows the descriptive measures of the physical examination categoric variables in relation to FEV_1. Table 3 shows the stepwise regression analysis for FEV_1, with an adjusted R^2 of 0.28. The significant variables in this model were use of neck accessory muscles, wheezing and expiratory time.

Discussion

In the present study, we observed that experienced physicians better perceived the severity of asthma attacks than patients. In addition, the physicians' score of severity correlated significantly with the degree of airway obstruction measured by spirometry (FEV_1), although the correlation coefficient was only 0.42 (P = 0.001).

Only dyspnea was significantly correlated with patient self-evaluation of asthma severity (adjusted R^2 = 0.16, stepwise regression) in our study. It is possible that patients use other criteria to determine asthma severity besides the variables measured in our study. However, we did not find any significant correlation between patients' score and FEV_1. Interestingly, Kunitoh et al. (10) demonstrated that among many variables only the degree of dyspnea rated on a Borg's scale remained predictive to discriminate hypoxia in acute asthma attacks, and that dyspnea was the only remaining predictor of hospitalization, with a sensitivity of 75% and a specificity of 78% (11). Morris et al. (12) studied asthmatic patients, comparing self-perceived severity of asthma and severity

Table 5. Categorical variables observed in physical examination and forced expiratory volume at the first second (FEV_1; % predicted) measured in the emergency room.

	Mean value of FEV_1	Standard deviation	Number of patients
Use of neck accessory muscles			
No	47.03	17.25	40
Yes	31.24	15.65	17
Wheezing			
Absent/little	54.71	15.68	17
Moderate/intense	37.05	16.68	40
Pulsus paradoxus >10 mmHg			
No	45.12	18.44	44
Yes	33.62	15.38	13
Intercostal retraction			
Absent	43.73	18.47	45
Present	37.00	16.68	12
Vesicular sounds			
Normal	42.09	17.41	32
Diminished	42.60	19.47	25
Cyanosis			
Absent	43.23	18.55	44
Present	39.23	17.20	13
Ronchi			
No	43.10	19.40	39
Yes	40.61	15.57	18
Wheezing in forced expiration			
Absent/little	51.73	15.86	15
Moderate/intense	38.95	17.92	42

scores with peak flow, and detected a significant association.

Shim and Williams Jr. (6) studied asthmatic patients who had used the Wright Peak Flow Meter in the past. These patients were asked to guess the values of their PEFR. Sixty-three percent of the estimates were within 20% of the measured value. In contrast, when physicians who took 3 to 5 min to examine the patient guessed the PEFR value, only 44% were within 20% of the measured value. Experienced patients were far more accurate in assessing their own PEFR than were the physicians. The main difference between our study and the study of Shim and Williams Jr. is that our patients were not experienced in measurement of airway obstruction. This raises the possibility that the ability to self-evaluate the severity of asthma attacks can be improved by training.

Boulet et al. (13) and Burdon et al. (14) using a histamine challenge, observed that patients with asthma showed a wide interindividual variability in the perception of airway obstruction. Rubinfeld and Pain (15) reported that airway resistance had to be increased substantially before symptoms were present and that 15% of the patients were unable to identify the presence of marked airway obstruction. Burki et al. (16) found that patients with asthma varied markedly in their ability to detect added resistive loads. In addition, Sont et al. (17) showed that the severity of breathlessness in patients with asthma is greater during hypertonic saline than during methacholine challenge at any given level of airway obstruction, suggesting that the intensity of asthma symptoms depends on the mechanisms involved in acute airway obstruction.

In the present study we also assessed the variables that influenced the physician's global evaluation of exacerbation severity. Use of neck accessory muscles, expiratory time, dyspnea, pulsus paradoxus, intensity of wheezing, intercostal retraction, decreased vesicular sounds, nares flaring, previous year hospital admissions, and previous orotracheal intubations were correlated with physicians' score (Table 1). Among these variables, in the stepwise regression, use of neck accessory muscles, expiratory time, hospital admissions in the previous year, pulsus paradoxus, intensity of wheezing, and nares flaring remained in the physician score model. However, among these variables, only use of neck accessory muscles, expiratory time, pulsus paradoxus, and intensity of wheezing were significantly correlated with objective measurement of airway obstruction (FEV_1). Pulsus paradoxus has been suggested to be a reliable indicator of the degree of airway obstruction, but it is not inevitably present when expiratory flow rates are very low (3,18-20).

It is interesting to note that a sign more used by pediatricians (nares flaring) correlates significantly with physician score. Expiratory time is not usually recorded because of technical difficulties in performing the procedure (the need for a chronometer, a single measure may be unreliable), but expiratory time was correlated with both the physician and the FEV_1 models, emphasizing the need to attribute a greater value to this sign. Although we did not evaluate the severity of the disease, but only the severity of the current crisis of the patient, it is interesting to note that some variables indicating disease severity (hospital admission, need for mechanical ventilation) correlated significantly with physician score.

We observed a significant correlation between physician global evaluation of the acute attack severity and FEV_1. It is important to note that although FEV_1 has been used as a "gold standard" to determine the severity of airway obstruction in acute asthma, there are other factors that substantially influence the prognosis of asthma attacks such as response to bronchodilators (21). In a study by Bailey et al. (22), scales using symptoms and clinical outcomes such as hospitalization and need for medication were compared to a judgmental scale by physicians, with PEFR as the objective measure, showing a significant correlation.

The ability of experienced physicians to assess the severity of asthma attacks has been previously investigated. Kelsen et al. (3) reported that measured airway obstruction was only modestly relieved in a group of patients treated in an emergency room who met conventional clinical criteria for discharge. In our study, in 15 patients (26% of total) the FEV_1 was lower than 40% predicted but the physicians gave a score ≥5, underestimating the severity of the asthma attack. This observation implies that even experienced physicians cannot identify all patients with severe airway obstruction using clinical criteria only.

One limitation of the present study was that we did not know the previous best FEV_1 values of the patients studied and so we were not able to define the severity of airway obstruction as a percentage of the personal best FEV_1. Since our purpose was to study patients not experienced in the regular use of peak flow meters, many of the patients studied were not under regular follow-up and, therefore, had not performed a spirometry in the past year.

We did not exclude patients who smoked, unless asthma developed after the beginning of smoking or patients had chronic cough or other symptoms suggestive of chronic bronchitis or chronic obstructive pulmonary disease. We observed that smoking status did not influence significantly either patient or doctor evaluation of the severity of the asthma attack, and did not correlate with the reduction in FEV_1.

The present study indicates that in the initial evaluation of the severity of asthma exacerbations, an objective measurement of airway obstruction must be used in conjunction with a carefully structured clinical evaluation. Patients' self-perception of the severity of their attack does not seem to add significant information to this initial evaluation. Some variables of the physical examination are very important for the determination of asthma attack severity, such as use of neck accessory muscles, expiratory time and intensity of wheezing, and so should be emphasized more in medical schools and emergency settings.

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