

## Evaluation of Predictors of Admission in Asthmatic Patients in Emergency Department

Morteza Saeedi<sup>1\*</sup>, Ali Taghizadieh<sup>2</sup>, Alireza Ala<sup>3</sup>, Payman Moharamzadeh<sup>3</sup> and Majid Zamani<sup>4</sup>

<sup>1</sup>Tehran University of Medical Sciences, Emergency Medicine Department, Shariati Hospital, Tehran, Iran

<sup>2</sup>Tabriz University of Medical Sciences, Emergency Medicine Department, Tuberculosis and Lung Diseases Research Center, Tabriz, Iran

<sup>3</sup>Tabriz University of Medical Sciences, Emergency Medicine Department, Iman Reza Hospital, Tabriz, Iran

<sup>4</sup>Isfahan University of Medical Sciences, Emergency Medicine Department, Iman reza Hospital, Isfahan, Iran

### Abstract

**Objective:** To evaluate admission predictors in asthmatic patients who come to emergency department (ED) with asthma exacerbation.

**Background:** Considering the increasing cases of asthmatic patients referring to ED we aimed to evaluate the factors effecting the prognosis and treatment to forecast the need for hospitalization or discharge.

**Material and methods:** 103 asthmatic patients with acute exacerbation of asthma were enrolled in the study and went under treatment. Spirometry was done before and during treatment on the basis of GINA principles. Pulse oximetry, P<sub>lmax</sub>, P<sub>E</sub>max was done and documented at arrival and 30, 60, 120 minutes after arrival.

**Results:** In admitted patients respiratory distress, intercostals retraction, function class (FC), pulse rate (PR), respiratory rate (RR), were significantly higher than discharged patients. Forced expiratory flow rate (FEV1%) (p<0.001), forced vital capacity (FVC) (p<0.001), FVC% (p<0.001), FEV1/FVC (p<0.001), peak expiratory flow rate (PEFR%) (p<0.001), saturation of peripheral oxygen SaO<sub>2</sub> (p<0.001), maximal inspiratory pressure (P<sub>lmax</sub>) (p<0.002) and maximal expiratory pressures (P<sub>E</sub>max) (p<0.001) were significantly lower in admitted patients in comparison with discharged patients.

**Conclusion:** In addition to FEV1 and PEF that have role in admission criteria, FEV1/FVC at arrival to ED and P<sub>E</sub>max after an hour after treatment can also be used to forecast the need for admission.

**Keywords:** Acute asthma; Hospital admission; Emergency ward

### Introduction

Asthma is a serious global health problem. The prevalence of asthma is increasing in most countries, especially among children. The burden of asthma is experienced not only in terms of healthcare costs but also as lost productivity. Public health officials require information about the costs of asthma care and education on methods to develop asthma care services and programs responsive to the particular needs and circumstances within their countries. Asthma is a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role. The chronic inflammation leads to recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning.

There is now good evidence that the clinical manifestations of asthma can be controlled with appropriate treatment. When asthma is controlled, there should be no more than occasional recurrence of symptoms and severe exacerbations should be rare [1]. The world health organization (WHO) has estimated that 15 million disability-adjusted life-yrs are lost annually due to asthma [2].

Although from the perspective of both the patient and society the cost to control asthma seems high, the cost of not treating asthma correctly is even higher [3-5]. Considering the increasing cases of asthmatic patients referring to Imam Reza hospital of Tabriz, we aimed to evaluate the factors effecting the prognosis and treatment to forecast the need for hospitalization or discharge.

### Material and Methods

In an analyzed descriptive cross sectional study, we studied one

hundred three patients who were referred with exacerbation of asthma or other acute asthmatic symptoms and went under treatment in Imam Reza hospital of Tabriz city in Iran.

### Study protocol

After taking complete history and physical examination, patients went under treatment with principles of GINA algorithm. Spirometry was done before treatment and during treatment on the basis of GINA principles.

Pulse Oximetry was done and documented at arrival and 30, 60, 120 minutes after arrival. P<sub>lmax</sub> and P<sub>E</sub>max were measured and documented at arrival and 60, 120 minutes after arrival. Primary treatment was performed in Emergency Department (ED) and the findings of discharged patients were compared with those who were admitted. Studied data were:

#### 1. Sex

**\*Corresponding author:** Morteza Saeedi MD, Tehran university of medical sciences, Emergency medicine department, Shariati hospital, Tehran, Iran, Tel: 982144263995; Fax: 982188220033; E-mail: [m\\_saeedi@tums.ac.ir](mailto:m_saeedi@tums.ac.ir)

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2. Age
3. Location
4. History of admission
5. Weight, Height and Body Mass Index (BMI)
6. Severity of respiratory distress, Pulse paradox
7. Intercostal retraction
8. Respiratory rate, Pulse Rate
9. Saturation of Peripheral Oxygen (SpO<sub>2</sub>)
10. ABG findings
11. Spirometry findings
12. Maximal Inspiratory Pressure, Maximal Expiratory Pressures (P<sub>I</sub>max, P<sub>E</sub>max)

### Inclusion criteria

1. Patients with history of Asthma
2. Exacerbation of symptoms

### Exclusion criteria

1. Other Pulmonary heart diseases like chronic obstructive pulmonary disease (COPD)
2. Congestive Heart Failure
3. Coronary Artery Disease
4. Pneumonia
5. Failure in follow up

### Statistical analysis & ethical considerations

Statistical analysis was performed by SPSS software package version 16.0 for windows (SPSS Inc., Chicago, USA). Quantitative data were presented as mean ± standard deviation (SD), while qualitative data were demonstrated as frequency and percent (%). In order to statistical analysis, collected quantitative data were studied with Student T-test (independent Samples), paired samples T-test and Man-Whitney U test and for Qualitative data statistical methods, the mean difference test for independent groups, and Chi Square2 test or Fisher's exact test. P value less than 0.05 was statistically considered significant in all steps.

All the procedures were on the basis of principles. Despite this, all participants have signed a written consent which was kept completely secret, and the study protocol was approved by the Ethics Committee of Tabriz University of Medical Sciences (TUMS), which was in compliance with Helsinki Declaration. Participation was completely voluntary and leaving the study was assured for all.

### Results

In this study, we considered 43 males (41.7%) and 60 females (58.3%). Mean age was 49 years old (7-94 y/o). Seventy eight (75.7%) patients were living in city and 25 (24.3%) were rural. Fifty one (49.5%) patients had history of hospitalization in which 19 (37.3%) were admitted in last 3 months, 11 (21.6%) were admitted between last 3-12 months before and 21 (41.2%) were admitted last years. Mean frequency of admission was 3.31 ± 0.49 times (1-20 times). Mean weight of patients was 72.17 ± 15.53 kilogram while mean height and BMI was 1.63 ± 0.09 meters and 26.94 ± 5.65.

Nine (8.7%) patients had FCI (function class) respiratory distress while 57 (55.3%) were in FCII, 28 (27.2%) were in FCIII and 9 (8.7%) were in FCIV respiratory distress category.

Pulse paradox was measured 10 mmgh in 81 (78.6%) cases while this rate was between 10 and 14 mmgh in 9 cases (8.7%), between 15 and 19 mmgh in 11 cases (10.7%) and more than 20 mmgh in only 2 (1.9%) patients. Grade +1 edema was seen in 100 patients (97.1%) while 3 (2.9%) cases were presented with Grade +2 edema.

Intercostal retraction was seen in 85 (82.5%) patients at arrival to ED, in 34 (33%) cases during admission. Mean respiratory rate was 28.43 ± 7.91 Time/Minute at arrival and 19.97 ± 5.73 during admission. Mean pulse rate was 109.34 ± 15.13 Time/Minute at arrival and 98.44 ± 12.08 during admission.

In ABG, mean PH was 7.36 ± 0.07 (7.09-7.64) while mean PCO<sub>2</sub>, HCO<sub>3</sub> and PO<sub>2</sub> were 38.50 ± 11.07 (18.60-83.10), 23.31 ± 7.50 (16.10-74.60) and 76.91 ± 22.05 (35.10-188) respectively.

Finally, 56 (54.4%) patients (30 males and 26 females) were hospitalized and 47 (45.6%) patients were discharged. Findings were compared: there was significant difference between hospitalization and sex (P value=0.001) and males were admitted more.

Thirty one of 51 (60.8%) patients with history of admission became hospitalized again while 25 of 52 (48.1%) patients without history of admission became hospitalized. There was no significant difference between these two groups (P value=0.23). Spirometric findings of patients at arrival and one and two hours after arrival are shown in Table 1.

After dividing the patients into two groups on the basis of pulse paradox; 36 patients 10 ≤ and 20 patients more than 10, There was significant difference between these two groups (P value=0.001) and patients with higher amount were admitted.

Grade +1 edema was seen in 53 (94.6%) admitted patients while grade +2 edema was seen in 3 (5.4%). Grade +1 edema was seen in 47 (100%) discharged patients while grade +2 edema was not seen (0%). There was no significant difference between these two groups (P value=0.24).

Fifty two (61.2%) patients were presented with intercostal retraction while it was not seen in 4 (22.2%). There was significant difference between these two groups (P value=0.004) and patients with intercostal retraction were admitted.

High function class (3 and 4) was more common in admitted

	First (At arrival)	Second (In first hour after arrival)	Third (In second hour after arrival)
FEV1	1.87 ± 0.32	1.50 ± 0.79	1.79 ± 0.91
FEV1%	56.30 ± 32.59	53.56 ± 32.08	62.66 ± 33.93
FVC	2.75 ± 1.12	2.90 ± 1.26	3.22 ± 1.48
FVC%	82.97 ± 34.84	82.53 ± 34.95	96.50 ± 53.07
FEV1/FVC	55.31 ± 16.30	52.82 ± 16.20	56.66 ± 16.98
FEV1/FVC%	68.69 ± 20.36	65.68 ± 19.93	70.66 ± 20.88
PEF	3.39 ± 0.53	2.61 ± 1.56	3.43 ± 2.11
PEF%	42.46 ± 29.21	38.15 ± 25.89	48.9 ± 31.38
FEF7525	0.24 ± 0.05	0.13 ± 0.03	0.19 ± 0.07
FEF7525%	6.99 ± 1.44	3.66 ± 0.99	4.81 ± 1.74
P <sub>I</sub> max	64.50 ± 20.35	70.79 ± 21.36	75.22 ± 22.57
P <sub>E</sub> max	66.98 ± 19.33	75.48 ± 20.82	79.73 ± 23.67

Table 1: Spirometric findings in 3 consecutive measurements.

		Admitted	Discharged	P value
At arrival	≥ 90%	9 (23.1%)	30 (76.9%)	<001/0
	80-89%	32(66.7%)	13 (33.3%)	
	>80%	15 (93.8%)	1 (6.2%)	
30 Minutes after	≥ 90%	24 (34.8%)	45 (65.2%)	<001/0
	80-89%	28 (93.3%)	2 (6.7%)	
	80%	4 (100%)	0	
60 Minutes after	≥ 90%	37 (44%)	44 (56%)	<001/0
	80-89%	14 (100%)	0	
	>80%	2 (100%)	0	
120 Minutes after	≥ 90%	40 (46%)	47 (54%)	_____
	80-89%	9 (100%)	0	
	>80%	2 (100%)	0	

**Table 2:** Arterial O<sub>2</sub> saturation in admitted and discharged patients.

patients (33 of 56) than discharged patients (4 of 46), There was significant difference between patients with respiratory distress (P value=0.001) and patients with higher FC who were admitted.

Lower O<sub>2</sub> saturation at arrival, 30 and 60 minutes after arrival is associated with higher rate of admission (Table 2). Due to irregular distribution of data in 120 minutes after arrival evaluation was not possible.

Mean age of admitted patients was 50.42 ± 16.81 years of old while it was 47.29 ± 18.26 years of old in discharged patients. There was no significant difference between age (P value=0.36), BMI (P value=0.34), height, weight, of admitted and discharged patients.

Mean respiratory rate of admitted patients was 31.17 ± 8.21 Time/Minute and 25.17 ± 6.18 in discharged patients at arrival. There was significant difference between two groups (P value=0.001) and patients with higher respiratory rates were admitted more.

Mean respiratory rate of admitted patients was 23.54 ± 5.84 Time/Minute and 16.10 ± 1.66 in discharged patients during admission. There was significant difference between two groups (P value=0.001) and patients with higher respiratory rates were admitted more.

Mean pulse rate of admitted patients was 114.64 ± 13.15 Time/Minute and 103.04 ± 15.03 in discharged patients at arrival. There was significant difference between two groups (P value=0.001) and patients with higher pulse rate were admitted more.

Mean pulse rate of admitted patients was 106.94 ± 9.01 Time/Minute and 88.48 ± 6.72 in discharged patients during admission or at discharge. There was significant difference between two groups (P value=0.001) and patients with higher pulse rate were admitted more.

Mean PH in admitted and discharged patients was 7.33 ± 0.07 and 7.40 ± 0.06 respectively. There was significant difference between two groups (P value=0.001). Mean PCO<sub>2</sub> in admitted and discharged patients was 42.47 ± 12.67 and 33.78 ± 6.17 respectively. There was significant difference between two groups (P value=0.001).

Mean HCO<sub>3</sub> in admitted and discharged patients was 24.40 ± 6.61 and 22.02 ± 8.32 respectively, There was no significant difference between two groups (P value=0.11).

Mean PO<sub>2</sub> in admitted and discharged patients was 68.36 ± 17.29 and 87.11 ± 22.92 respectively. There was significant difference between two groups (P value=0.001). Admitted patients had lower PO<sub>2</sub> in their ABG analysis.

Logistic regression analysis showed that sex (OR=5.12 and P value: 0.004), intercostal retraction at arrival (OR=5.11 and P value: 0.02) and

arterial O<sub>2</sub> saturation at arrival (OR=0.23 and P value: 0.001) can be used to forecast the need for hospitalization.

Respiratory rate at arrival (OR=0.3 and P value: 0.02), FEV1/FVC ratio in first measurement (OR=0.5 and P value: 0.006) and PEmax in second measurement (OR=0.85 and P value: 0.03) can also be used to forecast the need for hospitalization (Tables 3-5).

Ratio of FEV1/FVC, PEF, PImax, PEmax and FVC with cut-off point 50.4, 2.05, 62.5, 63.5 and 2.7 with 70% sensitivity were capable to forecast the need for hospitalization.

Quantitative data were evaluated with linear regression analysis to predict the need for hospitalization, in which these findings are adopted.

	Admitted	Discharged	P Value
FEV1	1.74 ± 0.85	1.95 ± 0.12	0.74
FEV1%	30.38 11.25	70.95 ± 31.59	<0.001
FVC	2.07 ± 0.83	3.13 ± 1.09	<0.001
FVC%	58.19 ± 22.39	96.98 ± 32.87	<0.001
FEV1/FVC	45.33 ± 12.53	61.17 ± 15.47	<0.001
FEV1/FVC%	55.46 ± 14.73	76.33 ± 19.32	<0.001
PEF	2.82 ± 1.35	3.74 ± 0.27	0.41
PEF%	20.30 ± 9.17	55.26 ± 29.19	<0.001
FEF7525	0.22 ± 0.05	0.25 ± 0.07	0.75
FEF7525%	6.42 ± 1.54	7.32 ± 2.1	0.76
Pimax	57.12 ± 18.55	70.88 ± 19.84	0.02
Pemax	45.53 ± 12.53	73.73 ± 15.47	<0.01

**Table 3:** Spirometric findings in first measurement.

	Admitted	Discharged	P Value
FEV1	1.06 ± 0.38	2.22 ± 0.78	<0.001
FEV1%	35.81 ± 10.88	82.92 ± 34.10	<0.001
FVC	2.55 ± 1.26	3.48 ± 1.06	0.003
FVC%	67.53 ± 26.97	107.34 ± 32.75	<0.001
FEV1/FVC	45.97 ± 13.68	64.15 ± 13.61	<0.001
FEV1/FVC%	57.16 ± 16.88	79.76 ± 16.45	<0.001
PEF	1.80 ± 0.86	3.95 ± 1.56	<0.001
PEF%	24.81 ± 11.18	60.23 ± 28.29	<0.001
FEF7525	0.16 ± 0.04	0.08 ± 0.05	0.3
FEF7525%	4.47 ± 1.25	2.34 ± 1.63	0.3
Pimax	60.67 ± 17.57	80.26 ± 20.37	<0.001
Pemax	64.30 ± 18.22	85.93 ± 17.52	<0.001

**Table 4:** Spirometric findings in second measurement.

	Admitted	Discharged	P Value
FEV1	1.19 ± 0.54	2.41 ± 0.79	<0.001
FEV1%	38.21 ± 13.19	88.22 ± 29.89	<0.001
FVC	2.76 ± 1.44	3.70 ± 1.39	0.002
FVC%	74.06 ± 30.66	119.95 ± 61.20	<0.001
FEV1/FVC	46.39 ± 13.58	67.17 ± 13.35	<0.001
FEV1/FVC%	57.95 ± 17.09	83.65 ± 15.87	<0.001
PEF	2.02 ± 1.27	4.90 ± 1.79	<0.001
PEF%	26.30 ± 11.36	72.54 ± 28.01	<0.001
FEF7525	0.13 ± 0.08	0.25 ± 0.12	0.42
FEF7525%	2.30 ± 0.91	7.43 ± 3.41	0.14
Pimax	65.54 ± 20.30	87.02 ± 19.38	<0.001
Pemax	65.54 ± 20.30	93.60 ± 17.89	<0.001

**Table 5:** Spirometric findings in third measurement.

## Discussion

Treatment of acute asthma in emergency department had been assayed in many researches [1]. Referred patients are judged for admission on the basis of response to treatment. It has been always a problem for physicians to hospitalize, discharge or continue the treatment in ED. Rapid response to treatment in ED is the best factor for admission evaluation considering the severity of symptoms. PEF change more than 50 L/Min of basic amount and more 40% of estimated amount show good prognosis [4]. In studies by Boychuk, Martin, Weber and coworkers they showed that 15%, 10.5% and 20% of patients referring with asthma attack symptoms were hospitalized, respectively [6-8]. In our study, 54.4% of patients were hospitalized that were more than other studies. This higher rate was due to higher severity of symptoms, as patients with severe respiratory distress, tachypnea and tachycardia were hospitalized more.

Many factors contribute in need for hospitalization. Boychuk et al. showed SpO<sub>2</sub> regardless of controlling the symptoms has direct relationship with hospitalization [6].

Previously done studies showed the accuracy of Pulse-oximetry and FEV1 measurement for forecasting the need for hospitalization in patients referring to ED [9-11]. Our study showed, lower SPO<sub>2</sub> is associated with higher rate of hospitalization with non-significant role in forecasting. Abnormal vital signs at arrival, tachycardia >130 Pulse/Min with severe dyspnea and air ways obstruction are associated with higher complications [12]. Pulse paradox >15 mmHg, intercostals retraction with FEV1<1 Liter and severe obstruction suggest the need for hospitalization [13-15]. In admitted patients, pulse paradox was decreased 20% during primary treatment, but in discharged patients from ED this rate was up to 60% [16]. Corroborating our study, Rayner et al. [17] showed, there is considerable difference between pulse paradox rate in discharged and admitted asthmatic patients, as patients with higher rate of pulse paradox were hospitalized more [17].

In a study by Golden role of BMI was studied in asthmatic patients [18]. In our study there was no difference in rate of previous admissions, location, mean age and BMI between two groups while using auxiliary muscles and intercostals retraction were in association with higher rate of hospitalization. We showed, PO<sub>2</sub>, HCO<sub>3</sub>, PCO<sub>2</sub> and PH in ABG findings were in association with rate of hospitalization, but sensitivity was insufficient.

Considering the reduced FEV1 in most of the pulmonary diseases, FEV1/FVC ratio has great role in our evaluations. Normal amount of ratio is between 0.75-0.8. Lower results show flow limitation. PEF measurement has great role in our diagnosis and treatment also [19,20]. Patients with pre-treatment FEV1 or PEF fewer than 25% of estimated amount or the best amount during admission or FEV1 or PEF lower than 40% are hospitalized almost. Patients with post treatment pulmonary function between 40-60% of estimated rate can be discharged [21]. Fanta et al. [22] found that asthmatic patients with FEV1 lower than 30% of estimated amount and patients with FEV1 more than 35% that were not treated, hospitalized more [22]. Stien and Cole showed that change in PEF after 2 hours treatment with bronchodilator can forecast the need for hospitalization [23]. Rodrigo and Rodrigo [24], showed discharged patients are those who have faster improvement in FEV1 in 30 minutes after treatment [24].

In our study, most of the tests had prominent difference between two groups, but FEV1/FVC ratio, PEF, PImax, PEmax and FVC had sensitivity more than 70% to caution the expectancy for admission with 50.4, 2.05, 62.5, 63.5 and 2.7 cut off points, respectively.

Wilson et al. [25] also did not suggest an absolute amount FEV1 for forecasting the need for admission also [25]. In our study, we found that sex, intercostals retraction at arrival, SpO<sub>2</sub> at arrival, respiratory rate at arrival, FEV1/FVC ratio at arrival and PEmax after an hour after treatment were able to caution the expectancy of hospitalization.

Weber et al. found that admission was in association with final PEF, female sex, nonwhite race, severity of chronic disease and exacerbation of symptoms [8]. We could not find a study evaluating the role of PEmax and PImax in admission and our study was the first one in which we measured them to caution the expectancy of hospitalization.

## Conclusion

In addition to FEV1 and PEF that have role in admission criteria, FEV1/FVC at arrival to ED and PEmax after an hour after treatment can also be used to forecast the need for admission. Spirometry and its findings can be helpful in performing appropriate procedure in ED.

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