

## Original Research Article

# Role of peak expiratory flow rate and chest radiography in children above 5 years of age with acute asthma

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## ABSTRACT

**Background:** Asthma is a heterogeneous disease characterized by cough, wheeze and shortness of breath that vary in intensity and time with variable expiratory airflow limitation, associated with chronic airway inflammation. Aim of the study was to assess the usefulness of Peak Expiratory Flow Rate [PEFR] and oxygen saturation in determining severity of acute asthma, to measure objective change in PEFR and oxygen saturation following bronchodilator therapy and the role of chest X-rays in acute asthma.

**Methods:** A prospective study of 50 children above 5 years with acute asthma who presented to the emergency department in a tertiary care hospital were included. PEFR and oxygen saturation before and after bronchodilator therapy was measured. Indication for chest X-rays, its clinical correlation and change in standard treatment of acute asthma based on X-ray reports was noted.

**Results:** The mean PEFR and PEFR % of expected was lower in severe asthma when compared to moderate asthma and was statistically significant ( $p < 0.001$ ). The % of expected PEFR before salbutamol therapy was  $48.78 \pm 14.36$ , which improved significantly to  $67.13 \pm 14.22$  after treatment ( $p < 0.001$ ). Oxygen saturation before and after salbutamol therapy was  $94.96 \pm 4.11$  and  $96.96 \pm 2.87$  respectively with the change being significant ( $p$  value  $< 0.001$ ). Chest X-rays were performed in 12 (24%) children as per standard guidelines, of which 1 (9%) was abnormal showing right basal consolidation. Chest X-ray correlated with clinical findings in 1 child and the findings on chest X-ray altered the ongoing treatment by addition of antibiotic.

**Conclusions:** PEFR and oxygen saturation is useful in the emergency department to objectively assess the severity of acute asthma and the response to initial bronchodilator therapy. Chest X-rays are not routinely indicated in the standard treatment of acute asthma.

**Keywords:** Acute asthma, Bronchodilator, Chest x-rays, Oxygen saturation, Peak expiratory flow rate

## INTRODUCTION

Asthma is a heterogeneous disease characterized by variable symptoms of wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity together with variable expiratory airflow limitation associated with chronic airway inflammatory disease.<sup>1</sup> The burden of asthma is immense, with more than 17, 23

million individuals in India currently suffering from asthma, with 6% of children being affected accounting for a worldwide burden of 300 million.<sup>2,3</sup>

The diagnosis of asthma is supported by clinical assessment of symptoms and its improvement with treatment.<sup>1</sup> Pulmonary function testing and pulse oximetry can be used as an adjunct in the diagnosis and

management of asthma as it is an objective and reproducible method to evaluate the severity of disease and the response to therapy.<sup>4</sup> PEFR and oxygen saturation are measured by simple portable devices which can be used in the emergency department to assess the severity of asthma on arrival and to record the response to bronchodilator therapy.<sup>5</sup> Chest X-rays are indicated only when there is inadequate response to treatment, suspicion of complication of asthma and alternate diagnosis.<sup>5,6</sup>

## METHODS

Author prospectively studied 50 children above 5 years of age admitted in a tertiary care hospital between September 2018 and August 2019 with acute exacerbation of asthma. Informed consent from parents was obtained. Institutional ethical committee approval was taken.

### Inclusion criteria

Children above 5 years of age admitted in the hospital with acute exacerbation of asthma were included

### Exclusion criteria

Children less than 5 years, children with wheeze due to other causes like allergic bronchitis, lower respiratory tract infections, viral bronchitis and those unable to perform PEFR were excluded.

Detailed clinical history and clinical examination was done on arrival at emergency department. Severity of acute asthma was assessed and classified based on British thoracic society guidelines into moderate asthma, severe asthma and life-threatening asthma.<sup>5</sup> Oxygen saturation at room air was noted on arrival and ten minutes after first bronchodilator nebulization. PEFR was measured through Wright's peak flow meter. Three consecutive readings were recorded by the peak flow meter each time prior to and after 10 minutes following bronchodilator therapy. Highest of three readings was considered. PEFR obtained was compared with standard nomograms for the age, sex and height of the child

If chest radiographs were ordered, it was correlated with clinical findings and indication for the same was recorded in a predesigned proforma. Change of management if any, based on chest x-ray reports was noted.

Data collected was analysed with SPSS software for mean, standard deviation and chi square test.

## RESULTS

### Age, sex and duration hospital stay

Study included 50 children aged between 5 and 15 years with 28 (56%) boys and 22 (44%) girls. The mean age of

boys was  $7.98 \pm 2.65$  years and that of girls was  $8.98 \pm 2.86$  years.

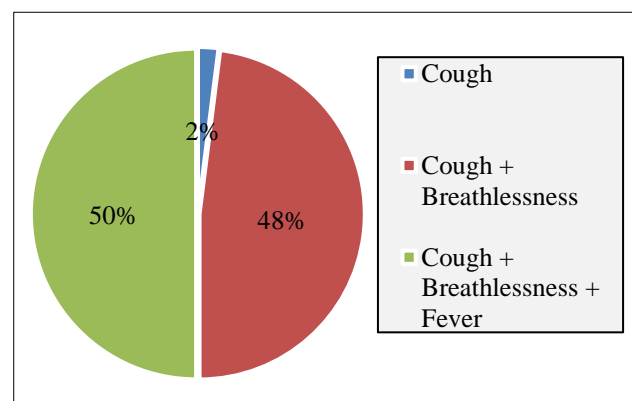
The average duration of hospital stay in the cohort was  $3.56 \pm 1.47$  days.

### Controllers

In this study 39 (78%) of the children were not on any controller treatment. The mean duration in children who were on controllers was  $3.09 \pm 1.64$  months

### Clinical presentation and findings

Most common presentation was cough which was present in all children (100%), followed by breathlessness in 49 children (98%) and fever in 25 children (50%) (Figure 1).



**Figure 1: Clinical presentation.**

Wheeze was the most common finding, which was present in all children, followed by chest retractions in 49 children (98%) and focal crackles in 11 children (22%).

### Classification of acute asthma

Nearly half (24 children, 48%) of the study population had severe asthma, 25 children (50%) had moderate asthma and one child had life threatening asthma. The mean PEFR at admission in moderate asthma, severe asthma and life-threatening asthma was  $124 \pm 42.83$ ,  $84.58 \pm 24.67$  and 70 respectively. The mean PEFR % of expected was  $58.84 \pm 12.11$ ,  $39.04 \pm 7.97$  and 31 in moderate asthma, severe asthma and life-threatening asthma respectively at admission. The mean PEFR and PEFR % of expected was lower in severe asthma as compared to moderate asthma, which was statistically significant ( $p < 0.001$ ) and it was the lowest in life threatening asthma (Table 1).

### Changes in PEFR and oxygen saturation in response to bronchodilator therapy

In cohort, the mean PEFR before salbutamol treatment was  $104.20 \pm 40.06$  which increased to  $137.80 \pm 45.05$  post treatment with a mean percentage change in PEFR of

17.92±6.40. The % of expected PEFR before salbutamol treatment was 48.78±14.36, which improved to 67.13±14.22 after treatment.

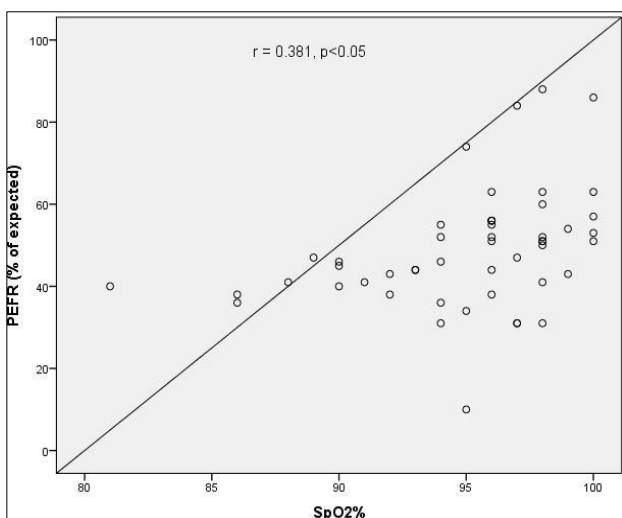
Oxygen saturation of children at room air on arrival to emergency department was between 81 to 100% with mean of 94.96±4.11, which improved to 88 to 100% with mean of 96.96±2.87 following bronchodilator therapy. The changes observed in the PEFR, PEFR (% of expected) and oxygen saturation before and after bronchodilator treatment were statistically highly significant with p value of <0.001 (Table 2).

**Table 1: Comparison of PEFR and PEFR % of expected between the study groups.**

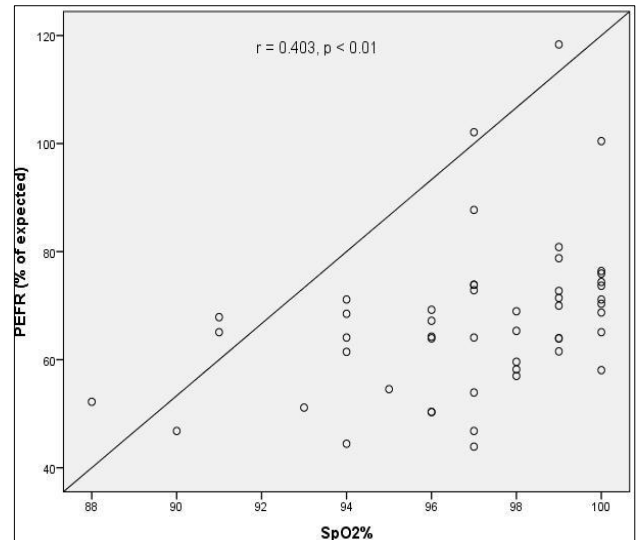
Study Group	PEFR (on admission)	PEFR % of expected (on admission)
	Mean±SD	
Moderate Asthma (n=25)	124.40±42.83	58.84±12.11
Acute Severe Asthma (n=24)	84.58±24.67	39.04±7.97
Life threatening Asthma (n=1)	70	31

**Table 2: PEFR and Oxygen saturation before and after salbutamol therapy.**

Parameters	Before salbutamol treatment	After salbutamol treatment	P value
PEFR	104.20±40.06	137.80±45.05	<0.001
PEFR (% of expected)	48.78±14.36	67.13±14.22	<0.001
Oxygen Saturation	94.96±4.11	96.96±2.87	<0.001



**Figure 2: Correlation between PEFR (% of expected) and SpO2 before salbutamol administration.**



**Figure 3: Correlation between PEFR (% of expected) and SpO2 after salbutamol administration.**

#### Correlation between PEFR and oxygen saturation

Positive correlation which was statistically significant was observed between PEFR (% of expected) and oxygen saturation before and after bronchodilator treatment, (r value 0.381 and 0.403 before and after salbutamol therapy with a corresponding p value of <0.05 and <0.01 before and after salbutamol therapy respectively) (Figure 2,3).

**Table 3: Correlation between focal chest signs and chest X-ray.**

	Normal Chest X-ray	Abnormal Chest X-ray	Total
Focal clinical findings	10	1	11
No focal clinical findings	1	0	1
Total	11	1	12

p= 0.753

#### Chest X-ray

Chest X-ray was done in 12 (24%) children on admission. The indication for ordering chest X-ray was presence of focal crackles in 11 (91%) and not responding to standard treatment in 1 (9%). Out of 12, only 1 chest X-ray correlated clinically. The correlation between chest x-ray report and focal chest signs were not statistically significant (p= 0.753) (Table 3). Chest X-ray reports by the radiologist revealed normal findings in 11(91%) and right basal consolidation in 1(9%). Chest X-ray findings did not alter treatment in almost all children except one, in whom IV antibiotics was added for right basal consolidation.

## DISCUSSION

Cohort consisted of 50 children above 5 years of age admitted with acute asthma.

There was statistically significant difference between mean PEFR and % of expected PEFR at admission in moderate asthma and severe asthma which was  $124.40 \pm 42.83$  (% of expected PEFR  $58.84 \pm 12.11$ ) and  $84.58 \pm 24.67$  (% of expected PEFR  $39.04 \pm 7.97$ ) respectively. Thus, mean PEFR and % of expected PEFR were lower in severe asthma when compared to moderate asthma. Mean PEFR before salbutamol therapy was  $104.20 \pm 40.06$  (% of expected PEFR  $48.78 \pm 14.36$ ) which increased to  $137.80 \pm 45.05$  (% of expected PEFR  $67.13 \pm 14.22$ ). The mean percentage change in PEFR before and after salbutamol therapy was 33%, indicating an objective measure of improvement following bronchodilator therapy. Statistically significant correlation between oxygen saturation and % of expected PEFR values before and after bronchodilator therapy (p value  $<0.001$ ) were noted demonstrating the usefulness of PEFR and oxygen saturation in an emergency setting.

In a study done by Srinivasa et al, in 50 children between 5-12 years of age, mean PEFR before and after bronchodilator treatment was  $120.8 \pm 33.18$  and  $146.6 \pm 35.02$  respectively. The mean percentage of improvement in PEFR was 21.3% after bronchodilator therapy which was statistically significant (p  $<0.001$ ), indicating its usefulness in monitoring response to treatment of acute asthma.<sup>4</sup> Similarly, in a case-control study done by Koripadu S et al, there was improvement in mean PEFR by 23 % reflecting response to treatment.<sup>7</sup> In a prospective observational study done by Andrade CR et al, in 196 children with acute asthma, measurements of peak expiratory flow and pulse oximetry were performed at admission and after 15 min of inhaled salbutamol cycle. There was significant correlation between % of expected PEFR and oxygen saturation (p value  $<0.0001$ ).<sup>8</sup>

Global initiative for asthma 2018 and British Thoracic Society 2019 guidelines recommend chest X-ray in acute exacerbations of asthma only when there is inadequate response to treatment, focal chest signs, suspicion of complications like pneumothorax, lobar collapse or consolidation, suspicion of foreign body aspiration or subcutaneous emphysema.<sup>1,5</sup> In this study, chest X-rays were done as indicated by these standard guidelines in 12 (24%) children on admission. The indications for performing chest X-rays were presence of focal signs in 11 and failure to respond to treatment in 1. Out of 12 chest X-rays done, the radiologists reports revealed that 11(91%) were normal, while 1 (9%) was abnormal. Abnormal chest X-ray report that was observed was right basal consolidation. Though focal chest signs were noted clinically in 11 (22%), the chest X-rays of these children were normal in 10 and 1 was abnormal. Chest X-ray findings correlated clinically in 1 child. Chest X-ray

reports altered the standard treatment of acute asthma, with the addition of antibiotics in one child who had right basal consolidation. The correlation between chest X-ray reports and focal chest signs were not statistically significant (p =0.753), probably because the sample size was small.

In a retrospective study done by Roback and Dreitlein, out of 298 children below 18 years admitted with acute wheeze, 121 (40%) had chest X-rays performed and 89 (73.6%) complied with standard guidelines. Localized wheeze, crepitations, and decreased air entry were the indications for performing chest X-rays in this study. Out of 121 chest X-rays performed, 29(24%) were abnormal. Chest X-ray reports revealed local infiltrates, consolidation and areas of increased density. Treatment was altered in all these children with abnormal chest X-rays.<sup>9</sup> Brooks et al, in their study on significance of chest X-rays in children with acute asthma showed that out of 128 chest X-rays that were performed, 36 (28%) were abnormal, of which 3 (8%) correlated clinically. Out of 36(28%) abnormal chest X-rays, treatment was altered in only 3(8%).<sup>10</sup> Hence they concluded that routine chest X-rays were not indicated in the standard treatment of acute asthma. In contrast, a retrospective study done by John S et al, on usefulness of chest X-rays in acute asthma, showed that focal chest findings were present in 19 out of 114 children of which 9 correlated clinically with a highly statistically significant p value of  $<0.001$ . This is probably because their sample size was large in comparison to the study sample.<sup>11</sup>

## CONCLUSION

Peak Expiratory Flow Rate and oxygen saturation is useful in the emergency department to objectively assess the severity of asthma and response to bronchodilator therapy. Chest X-rays is not routinely indicated in the standard treatment of acute asthma.

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