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Original Research Article

Effect of lower respiratory tract infections on peak expiratory flow rate in children admitted to Rajarajeshwari medical college hospital, Bangalore, Karnataka, India

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ABSTRACT

Background: Peak expiratory flow rate is the simplest , cost effective and easily available test to assess the respiratory function. PEFR is measured by a peak expiratory flow meter. Measurement of PEFR is most commonly used for asthmatic patients. To evaluate the effect of lower respiratory tract infection on peak expiratory flow rate in children.
Methods: PEFR were measured in eighty children suffering from LRTI by peak flow meter . Height and weight were measured. PEFR was compared with the normal charts. mean PEFR was calculated and predicted percentage of PEFR was calculated.
Results: Mean PEFR in pneumonia , para pneumonic effusion, bronchiectasis, and bronchitis was 187.2 , 187.6, 171.85 and 173.1 respectively. Mean PEFR was maximally reduced in bronchiectasis and bronchitis. Mean PEFR was reduced in female children in comparison to males with LRTI. PEFR was decreased more in children with severe clinical presentation and with malnutrition.
Conclusions: In this study , most common LRTI was pneumonia followed by parapneumonic effusion. PEFR was maximally reduced in bronchiectasis and bronchitis. Undernourished children were more affected.

Keywords: Children, LRTI, PEFR

INTRODUCTION

Acute respiratory tract infection is the leading cause of morbidity and mortality in both developing and developed countries. WHO recognized respiratory diseases as the second most important cause of death for children under five years in 2010. WHO states that pneumonia is one of the main three causes for newborn and infant deaths.

Respiratory tract infections comprise a group of symptoms and signs referable to respiratory tract, caused by a variety of pathogens including bacteria and viruses and can be upper respiratory tract infection and lower respiratory tract infection.[1]

The division of respiratory system into upper and lower tract is in reality a clinical convenience related largely to the spread of infection rather than any fundamental anatomical concept. The upper respiratory tract can be defined as those parts of air passages which lie above the in left to the larynx namely the nasal cavities, nasopharynx, and oropharynx. The lower respiratory tract comprises the larynx, trachea and rest of the respiratory tree.[1] Viral pneumonia usually results form spread of infection along the airways accompanied by direct injury of respiratory epithelium. This results in airway obstruction from swelling, accumulation of abnormal secretions and cellular debris. Atelectasis, interstitial edema and ventilation-perfusion mismatch causing significant hypoxemia often accompany airway obstruction. Viral infection of the respiratory tract can also predispose to secondary bacterial infection by disturbing the normal host defence mechanisms, altering the nature of secretions, and modifying the bacterial flora.

Bacterial pneumonia most often occurs when respiratory tract organisms colonize the trachea and subsequently gain access to the lungs, but pneumonia can also result from directly seeding of lung tissue after bacteraemia. When a bacterial infection is established in the lung parenchyma, the pathological process varies according to the invading organisms.

M pneumoniae attaches to the respiratory epithelium, inhibits the ciliary action and leads to cellular destruction and an inflammatory response to the submucosa. S. pneumoniae produces local edema that aids in the proliferation of organisms and their spread to the adjacent portions of the lung, often resulting in characteristic focal lobar involvement. Group A streptococcal infection results in more diffuse infection with interstitial pneumonia. The pathology includes necrosis of tracheobronchial mucosa formation of large amount of exudates, edema and local hemorrhage .

Peak expiratory flow rate is defined as the maximum flow which is achieved during an expiration delivered with maximal force starting from the level of maximal lung inflation.[2] Peak flow meters employ the principle of variable orifice to measure airflow indirectly. The pressure exerted by a forced expiration causes a diaphragm or vane to move and, in doing so, to open a progressively large area of orifice.

The point at which no further movement of the diaphragm occurs depends on the maximal pressure and the peak expiratory flow that has been generated.[3]

PEFR is dependent on[3]

- The alveolar pressure generated by the subject .
- The flow resistance of intra and extra thoracic airways and by the added resistance due to the instrument.

The determinants of PEFR are[3]

- The elastic properties of the larger thoracic airways.
- Elastic recoil capacity of the lungs .
- The resistance of the smaller intra-thoracic airways.

In healthy subjects, PEFR is determined[3]

- The volume of the lungs (which is a function of the thoracic dimensions and hence the stature)
- The elastic properties of the lung
- The power and coordination of expiratory muscles

PEP may also be impaired[3]

- Obstruction in the extra thoracic airways .
- Conditions which affect respiratory muscle function or limit chest expansion .
- The integrity of the neural system

In restrictive disease like interstitial lung disease, the effect of a loss in lung volume on PEFR may be offset by increased lung elastic recoil. In subjects with severe airflow obstruction like PEFR may include air coming from collapsing airway in addition to flow coming from lungs. In that case PEFR may underestimate the degree of airway obstruction.

METHODS

Eighty children in the age group of 6 to 18 years, of both sexes suffering from lower respiratory infection admitted in pediatrics department of Rajarajeswari medical college and hospital were selected for the study during the study period . Proper consent was taken from the parents before starting the study.

Exclusion criteria

- Eighty children in the age group of 6 to 18 years, of both sexes suffering from lower respiratory infection admitted in pediatrics department of Rajarajeswari medical college and hospital were selected for the study during the study period.
- Proper consent was taken from the parents before starting the study.

The anthropometric measurements taken were height (cm) and weight (kg)

Weight (Wt) was measured in kilograms (kgs) using standard weighing machine. Standing height (Ht) was measured in cenitmeters (cm) by making the child stand against a fixed calibrated rod with adjustable headrest. PEFR was measured by a mini Wright's peak flow meter (600-800 L/min). Graduation starts with 50 L/min to 800 L/min with accuracy of 10 L/min. Indicator of PEFR remains in place of reading unless brought back manually by the operatory. All measurements of PEFR were taken in the standing position.

The purpose of the test and the procedure was explained to the children and their parents. The procedure was demonstrated in detail so as to familiarize them with the procedure and to get their full cooperation.

Each child was told to take a deep breath and then blow into peak flow meter as hard and as fast as possible through the mouth piece and was closely watched to ensure that the child maintained an air tight seal between the lung and the mouth piece of the instrument.

Th procedure was repeated thrice, highest value among the three readings was taken as observed PEFR. Disposable mouth piece was used for recording PEFR. Observed PEFR was compared with normal charts. Mean PEFR was obtained for different types of LRTI and according to the gender distribution

Main requirements to record a correct PEFR with regard to the recording equipment are[4]

- The accuracy of the readings must comply with the values agreed upon
- the frequency response must be adequate
- PEFR should not be influenced by the internal resistance of the meters.

Steps for recording PEFR[5]

- The peak flow meter should read zero
- While standing up straight, take a deep breath
- Place the peak flow meter in the mouth, with the tongue under the mouth piece.
- Close the lips tightly around the mouth piece
- Blow out as hard and fast as possible
- Breathe a few normal breaths and then repeat the process two more times – write down the highest number obtained and do not average the number.

Data analysis was done using student t test and chi square test.

RESULTS

The subjects of the present study consist of 80 children suffering from lower respiratory tract infection. 31.2% of the children were in the group of 6-8 years , 27.6% between 9-11 years , 21.2% between 12-14 years and 20% between 15-18 years (Table 1).

Table 1: Age distribution of cases.

Age group	Number of cases	Percentage
6-8 years	25	31.2
9-11 years	22	27.6
12-14 years	17	21.2
15-18 years	16	20
TOTAL	80	100

Maximum children were male in this study group and most of the male children belonged to 6-8 years age group (Table 2).

Table 2: Sex distribution according to age.

Age group	Male	Female
6-8 years	20 (38.5%)	5 (17.9%)
9-11 years	12 (25.0%)	9 (32.1%)
12-14 years	10 (19.2%)	7 (25.0%)
15-18 years	9 (17.3%)	7 (25.0%)
Total	52	28

In this study group (Table 3) , majority of the children , 54 in number were suffering from pneumonia which 67.5%, followed by parapneumonic effusion 15 in number which constituted 18.75%, Bronchiectasis was diagnosed in 7 children (8.75%) and 4 children had Bronchitis (5%).

Table 3: Total case distribution.

	Number of Cases	Percentage
Pneumonia	54	67.5
Parapneumonic effusion	15	18.75
Bronchiectasis	7	8.75
Bronchitis	4	5

Mean age for boys in this study was 9.91, 10.7, 13.5, and 9.0 with pneumonia, parapneumonic effusion, bronchiectasis and bronchitis respectively.

Table 4: Mean age, height and weight in LRTI according to sex distribution.

Diagnosis	Mean Age		Mean Height		Mean Weight	
	Male	Female	Male	Female	Male	Female
Pneumonia	9.91	11.47	126.32	132.35	29.80	32.00
Parapneumonic effusion	10.70	10.33	133.44	127.83	31.50	29.00
Bronchiectasis	13.50	12.33	133.00	133.30	31.00	29.00
Bronchitis	9.00	13.50	127.50	142.00	24.00	34.50

Mean height in centimeters was 126.32, 133.44, 133.00 and 127.50 and mean weight in kilograms was 29.8, 31.5, 31.0 and 24.0 in pneumonia, parapneumonic effusion, bronchiectasis and bronchitis respectively (Table 4).

Table 5: Sex distribution according to diagnosis.

	No. of males (%)	No. of females (%)
Pneumonia	37 (71.2%)	17(60.7%)
Parapneumonic effusion	9(17.3%)	6(21.4%)
Bronchiectasis	4(7.7%)	3(10.7%)
Bronchitis	2(3.8%)	2(7.2%)
Total	52	28

In this study (Table 5) with pneumonia , 37 male children had pneumonia (71.2%) as compared to 17 female children (60.7%). With paracardiac pneumonia, 9 were male children (17.3%) as compared to 6 female children (21.4%). 4 male children had Bronchiectasis (7.7%) as compared to 3 female children (10.7%). With Bronchitis , 2 were male children (3.8%) as compared to 2 female children (7.2%). Table 6 shows age distribution according to diagnosis of patients. Maximum number of children (n=48) with pneumonia belonged to 6-8 years group whereas most of the children with bronchiectasis belonged to adolescent age group (15-18 years) and 9-11 years .

Table 6: Age distribution according to diagnosis.

Age	Pneumonia	Parapneumonic effusion	Bronchiectasis	Acute Bronchitis
6-8 years	48	6	0	1
9-11 years	15	4	3	1
12-14 years	15	1	1	1
15-18 years	6	4	3	1
Total	54	15	7	4

Acute Bronchitis was diagnosed equally in all age groups. Parapneumonic effusion was rarely diagnosed in children between 1-14 years of age. In this study, mean PEFR was maximally reduced in bronchiectasis followed by bronchitis. Mean PEFR in bronchiectasis was 171.85, 173.10 in bronchitis, 187.20 in pneumonia and 184.60 in parapneumonic effusion (Table 7).

Table 7. Mean PEFR according to diagnosis.

Diagnosis	Mean PEFR
Pneumonia	187.20
Parapneumonic effusion	184.60
Bronchiectasis	171.85
Bronchitis	173.10

Table 8: Predicted percentage of PEFR in different LRTI.

% predicted PEFR	Pneumonia (n=54)	Parapneumonic effusion (n=15)	Bronchiectasis (n=7)	Bronchitis (n=4)	Chi square test
≥ 80 %	30 (55.6%)	9 (60.0%)	3 (42.8%)	1 (25%)	$x^2 = 1.9$ P=0.58 (not significant)
< 80 %	24 (44.4%)	6 (40.0%)	4 (57.2%)	3 (75.0%)	

Table 9: Mean PEFR according to clinical severity.

Mean PEFR	Pneumonia	Parapneumonic effusion	Bronchiectasis	Bronchitis
With chest retraction	174.35 ± 38.7	171.6 ± 42.2	155.0 ± 41.2	160.7 ± 27.3
Without chest retraction	194.5 ± 51.8	199.5 ± 58.9	194.3 ± 36.0	185.5 ± 7.8
P value (t test)	0.146	0.306	0.240	0.340
	Pneumonia	Parapneumonic effusion	Bronchiectasis	Bronchitis
SpO_2 > 90%	188.0 ± 49.3	185.8 ± 47.2	212.5 ± 24.7	180.0 ± 0
SpO_2 < 90%	185.4 ± 46.6	182.2 ± 63.4	155.6 ± 35.7	170.8 ± 26.1
P value (t test)	0.861	0.901	0.101	0.789

Table 10: Predicted percentage of PEFR in LRTI according to symptomatology.

	Pneumonia (n=54)		Parapneumonic effusion (n=15)		Bronchiectasis (n=7)		Bronchitis (n=4)	
Chest retraction	< 80%	> 80%	< 80%	> 80%	< 80%	> 80%	< 80%	> 80%
Present	21 (38.9%)	9 (16.6%)	3 (20.0%)	5 (33.3%)	3 (42.8%)	1 (14.3%)	1 (25.0%)	1 (25.0%)
Absent	13 (24.1%)	11 (20.4%)	3 (20.0%)	4 (26.7%)	1 (14.3%)	2 (28.6%)	2 (50.0%)	0
P value (Exact test)	0.231		0.999		0.486		0.999	

Table 11: Predicted percentage of PEFR in LRTI according to oxygen saturation.

	Pneumonia (n=54)		Parapneumonic effusion (n=15)		Bronchiectasis (n=7)		Bronchitis (n=4)	
SpO_2	< 80%	> 80%	< 80%	> 80%	< 80%	> 80%	< 80%	> 80%
> 90%	15 (27.8%)	24 (44.4%)	3 (20.0%)	7 (46.7%)	0	2 (28.6%)	1 (25.0%)	0
< 90%	9 (16.7%)	6 (11.1%)	3 (20.0%)	2 (13.3%)	4 (57.1%)	1 (14.3%)	2 (50.0%)	1 (25.0%)
P value (Exact test)	0.223		0.329		0.143		0.999	

This table (Table 8) shows the changes in predicted percentages of PEFR in LRTI. 30 out of 54 children with Pneumonia had PEFR < 80%. 9 out of 15 children with parapneumonic effusion had PEFR < 80%. 1 out of 4 children with bronchitis had PEFR < 80%. This table explains the mean PEFR in LRTI in relation to the severity of symptomatology. The mean PEFR is less in children who presented with severe clinical presentation like chest retraction and lesser saturation at admission (<90%). Mean PEFR was maximally reduced in children with bronchiectasis who had chest retraction and saturation less than 90% compared to other children who were clinically stable (Table 9). Table 10 and table 11 explains the change in predicted percentage of PEFR in LRTI according to the severity of symptomatology. In pneumonia, 38.9% presented with chest retraction with a fall in PEFR of more than 80% whereas 27.8% children with pneumonia had saturation less than 90% and PEFR <80% of predicted. In paraneumonic effusion, 20% children with severe symptomatology had PEFR <80%.

DISCUSSION

Peak expiratory flow rate is a measurement which is dependent upon various variables including airway resistance, maximal voluntary muscular effort and the possible compressive effect of the maneuvers on intra-thoracic airways. The ventilator functions like maximum breathing capacity and the forced expiratory volume at one second have correlated well with peak expiratory flow rate.[6,7] In this study, most of the children presented with cough followed by fever and respiratory distress. Some of the children also presented with associated symptoms of upper airway tract infection. Most of the children in this study belong to the age group of 6-8 years and majority are male children suffering from pneumonia. In this study, most of the children suffering from pneumonia were between the age group of 6-8 years though pneumonia is more common among under five age group children. Children with bronchiectasis were mostly adolescents (n=7). In this study, change in PEFR of the children was correlated with the mean age, height and weight. There are various studies which show the change in peak expiratory flow rate in relation to anthropometry. One study done by Manjunath CB and Kotinatot CS et al. on school children between age group of 5 to 16 years concluded that PEFR values increased in linear relation to age, sex and height. Height correlated better with PEFR than weight and sex.[8] In their study, the mean age, height and weight for boys were 10.68 years, 138.57 centimeters and 31.23 kilograms. The mean age, height and weight for girls were 10.49 years, 135.45 centimeters and 30.18 kilograms which correlated well with the present study. The mean PEFR values in the reference study were 292.85 and 255.00 for boys and girls respectively. In present study, a fall in mean PEFR in both boys and girls was noted in all four varieties of LRTI. The fall in PEFR was observed to be more in girls compared to boys. In the present study, BMI was plotted on WHO growth charts . There were 6 obese children and 12 thin children presented with pneumonia. There were 2 very thin children with bronchitis and paracardiac effusion respectively. These children had PEFR lass than 80% of predicted.

In the study by R. Primhak et al, they concluded that malnutrition has a negative effect on PEFR, possibly due to impaired muscle function. Chronic malnutrition affects the somatic growth more than the growth in lung function.[9] In another study by Basuli et al, on "Peak expiratory flow rate – a consistent marker of respiratory illness associated with childhood obesity" hypothesized that fat accumulation over the chest wall reduces PEFR more among all the pulmonary function indices.[10] The children who presented with sever clinical presentation like intercostal and subcostal retractions and low saturation at the time of admission had lower PEFR compared to those children who were clinically stable. This difference was seen in all the varieties of LRTI. But maximum reduction in mean PEFR was seen in children with bronchiectasis. Similarly, when the fall in PEFR was calculated in terms of predicted percentage, it was seen that children with severe clinical manifestation had PEFR less than 90% of the predicted. Though the reduction in PEFR predicted percentage is not statistically significant (p-0.24), the reduction can be explained by the statement 'Peak expiratory flow usually assesses the upper airway'. In present study, 57.2% of children with bronchiectasis (n=7) had <80% of PEFR. These children had PEFR percentage ranging between 65% to 70% of predicted. In present study, there were total 15 children with parapneumonic effusion. Mean PEFR among them was 184.6. 40% of these children had PEFR less than 80% of predicted. Seven patients with bronchiectasis had mean PEFR of 171.85. In one child, the bronchiectasis was secondary to cystic fibrosis and two patients had bronchiectactic changes secondary to tuberculosis. In the studies of A Srivastava et al, observed in their study that in pneumonia there was a significant decline in the values of FVC and FEV1 along with insignificant decrease in flow rates PEFR.[11]

CONCLUSION

Eighty children in the age group of 6-18 years suffering from lower respiratory tract infection were selected for the study. Their height and weight were measured. PEFR was measured with the help of Wright's peak flow meter. Best of the three values were taken for the study. Four different varieties of lower respiratory tract infection in children were included in the study namely pneumonia, parapneumonic effusion, bronchiectasis and bronchitis. Pneumonia was most commonly reported among all children (67.5%). Male children (65%) were affected more as compared to the female children. PEFR was maximally reduced in bronchiectasis and bronchitis. The lung function tests were also reduced in children who had severe clinical symptoms at the time of presentation. Respiratory diseases are more common in children and are the leading cause of death worldwide. Early detection and prompt treatment helps in improving the survival. Peak expiratory flow is an inexpensive and easily available test which can be used to monitor the severity of lower respiratory tract infections beside asthma. In this observational study, single PEFR was measured at the time of first clinical presentation. Predicted percentage of PEFR was reduce more in children with bronchiectasis and bronchitis but it was not statistically significant. The children who had severe clinical presentation had more decline in PEFR values. This could be due to acute illness. To summarize, PEFR measurement is a test for upper airways. Performing this test during the acute stage of respiratory illness may not useful but serial monitoring of PEFR and other lung function tests during the course of illness and at discharge and follow-up can help to tailor the treatment and improve the outcome of the child.

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