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Original Research Article

Using a peak flow meter to assess severity of exacerbation in patients suffering from chronic obstructive pulmonary disease: a prospective observational study

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is an important and dangerous public health concern, and deaths due to it has become the leading cause of mortality in several countries. Exacerbations of the disease are very common and is frequently responsible for progressive decline in lung function, quality of life and ultimately death. Through this study, we hypothesize whether estimating peak expiratory flow rate (PEFR) using a simple peak flowmeter could help in early prediction of the intensity and severity of exacerbations of COPD.
Methods: This study was conducted amongst 100 patients, at Amrita Institute of Medical Sciences, Kochi, Kerala, who were diagnosed with COPD, based on GOLD criteria and respective pulmonary function tests. Their PEFR and oxygen saturation values were recorded during their routine clinic visits and during an exacerbation episode and results were analyzed.
Results: Out of 100 patients, 91 were males and 9 were female patients, with a mean age of 64.4 years and commonest age affected is 55 years. Average duration of COPD amongst the study participants ranged from 4 to 11 years with a mean of 7.19 years. PEFR was graded into 3 zones based on guidelines and measurements noted. Of the 76 male patients with 80-100% PEFR recordings, 10 (13.15%) had a drop to 50-80% PEFR and 66 (86.85%) of them dropped to <50% PEFR reading during an exacerbation. For the female subjects, of the 9 patients with 80-100% of expected PEFR, 3 (33.33%) had dropped to 50-80% and 6 (66.69%) had dropped to <50% of PEFR reading. SpO2 had significant change at exacerbations as compared during normal phase dropping with mean of 94.82 to 81.3 which was statistically significant across age and gender. Wilcoxon signed rank test was done to quantify statistical change showed z score of -9.138 with $p<0.0001$, which was significant across age and gender groups.
Conclusions: As a simple, inexpensive tool, peak flowmeter could be useful for bedside monitoring of severity of exacerbation of COPD. This could be vital for early detection and appropriate medical intervention.

Keywords: PEFR, COPD, Exacerbation, Peak flow, Peak flowmeter, SpO_2

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) remains one of the most important leading causes of morbidity and mortality. It is a progressive and a debilitating disease with recurrent episodes of exacerbations, which associates with poorer quality of life and increased mortality numbers.[1,2] Current available guidelines and classification systems utilize the spirometry values which are used to diagnose and monitor the disease progress.[3,4]

PEFRs has been traditionally used to monitor disease activity in patients diagnosed with bronchial asthma, the values were quickly estimated with a simple peak flow meter.[5] The peak flowmeter's main advantages include its portability, convenience and good patient compliance.

It's role in estimating severity in COPD exacerbations, remains far unclear. Some studies have shown positive associations between the PEFR values and COPD disease status (exacerbation frequencies).[6,7]

Some studies have shown that PEFR monitoring in COPD patients, is useful in predicting airflow resistance at an earlier stage, and further increases, if patient compliance also increases.[8,9] A good relation between FEV_1 and PEFR have been reported in COPD patients, further strengthening use of PEFR in an office/home-based setting.[10]

We attempt to use this PEFR values against monitoring disease activity in COPD (values obtained during routine OPD visits and during an exacerbation). We also try to analyze daily PEFR variability in patients with severe COPD status, as a marker for disease instability.

METHODS

This was a prospective study carried out at Amrita institute of medical sciences, Kochi, Kerala, from December 2012 to December 2013. A total of 100 patients were included in the study, after obtaining their informed consent.

Patients, who were diagnosed to COPD, based on spirometry and GOLD criteria were only included.[1] Such patients are informed about the study design, and their PEFR values are obtained and noted, during routine hospital visits (stable), and during an exacerbation episode(s). Along with the PEFR recordings, oxygen saturation values, using a standard pulse-oximeter, are also obtained, before any medical intervention is given, during both the occasions (stable visit and during and exacerbation). Patients with any co-existing lung conditions apart from COPD were excluded from study.

Study design and procedure

PEFR was measured using a standard peak flow meter. The readings are taken, based on zone measurements, according to American lung association, into green, yellow, and red zones (Table 1).[11] Oxygen saturations are recorded using standard pulse-oximetry device.

Informed consent was obtained from each patient, before enrolling them to the study, after explaining in detail about the study protocol, in their vernacular language. All the information was collected confidentially, without any undue force or pressure.

The correlation between outcomes (PEFR values during stable and exacerbations episodes) and the predictor variables was based on logistic regression analysis for which correlation was tested by chi-square method (x^2). Age data was compared by unpaired t test. Wilcoxon signed rank test was done to quantify statistical change showed z score of -9.138 with $p<0.0001$, which was significant across age and gender groups.

Table 1: Zone of PEFR recording in a flowmeter with their corresponding readings.[11]

Zone	Readings	Descriptions
Green zone	80 to 100% of the usual or normal peak flow readings are clear	A peak flow reading in the green zone indicates that airway status is in good control.
Yellow zone	50-79% of the usual or normal peak flow readings	Indicates caution. It may mean respiratory airways are narrowing and additional medications are required.
Red zone	Less than 49% of the usual or normal peak flow readings	Indicates a medical emergency. Severe airway narrowing may be occurring and immediate action needs to be taken. This would usually involve contacting a doctor/hospital authority.

RESULTS

Among the 100 study participants in our study, 91 were males and 09 were females, belonging to the age group between 44-85 years, with a mean age being 64.4 years (9.93 % participants), with the most common age being affected is 55 years (8% of participants).

Study participants reported duration of COPD ranging from 4 to 11 years, with a mean of 7.19 years (1.59% of participants), the most common duration being 8 years (25%) (Table 2).

PEFR measured during normal phase among males showed 76 of them (83.5%) to be at 80-100% of PEFR, 15 (16.5%) to be at 50-80% of PEFR predicted values. Amongst females, 9 of them (100%) were at 80-100% of predicted PEFR, with none of them below 50% of PEFR.

During an exacerbation phase, 81 of males (89.01%) were at <50% of PEFR, while 10 of them (10.98%) at 50-80% of PEFR. Amongst females, 6 (66.66%) were at <50% of PEFR predicted while 3 of them (33.33%) at 50-80% of PEFR.

Oxygen saturations (SpO_2) had also a significant change at exacerbations as compared to normal phase dropping with a mean of 94.82 (normal) to 81.3 (exacerbation), which was statistically significant across age and gender ($t=48.76$ with $p<0.0001$) (Table 2).

Pattern of change in PEFR was recorded during a normal phase and during an exacerbation phase. It was observed that 10 out of 76 males (13.15%) and 3 of 9 females (33.33%) had a worsened PEFR recording from 80-100% predicted to 50-80%, while the much majority of them, 66 of 76 males (86.85%) and 6 of 9 (66.66%) females worsened from 80-100% predicted PEFR to <50% values. Also, 15 of 91 males (16.5%) with a predicted PEFR of 50-80%, worsened to <50% PEFR during an exacerbation (Table 3).

Table 2: Presentation pattern during normal and exacerbation phase of COPD.

Variables		Normal phase PEFR		Exacerbation phase PEFR		Total
		80-100%	50-80%	50-80%	<50%	
Gender	Male	76	15	10	81	91
	Female	9	0	3	6	9
Age (years)	44-55	21	1	3	19	22
	56-65	26	4	4	26	30
	66-75	26	5	3	28	31
	76-85	12	5	3	14	17
Years of COPD (years)	Upto 6	31	5	6	30	36
	7-11	54	10	7	57	64
SpO_2	Mean	94.82		81.3		t=48.76
	SD	0.68		2.67		p<0.0001
	Median	95		81		
	Mode	95		84		
	Range	94-96		77-85		

Table 3: Changing pattern during exacerbation phase compared to normal phase.

Variables (%)		Normal phase	Exacerbation	
			50-80%	<50%
Gender				
80-100	Male	76	10	66
	Female	9	3	6
50-80	Male	15	0	15
	Female	0	0	0
Age group (years)				
44-55	80-100	21	3	18
	50-80	1	0	1
55-65	80-100	26	4	22
	50-80	4	0	4
66-75	80-100	26	3	23
	50-80	5	0	5
76-85	80-100	12	3	9
	50-80	5	0	5

DISCUSSION

Through our study findings, we observe that by using a simple peak flow meter with the patient by the bedside, could help in an early assessment of the disease state, and probably avoiding an exacerbation episode, with its associated complications. Most of our patients, majority being males, with an average age of fifty-five years, had a significant drop in their PEFR recordings when they came during an exacerbation episode, as compared to their baseline PEFR recordings. The corresponding drop in their oxygen saturation value also determine severity in their exacerbation. Hence, due to the early detection of the exacerbation episode, appropriate medical therapy could be applied as well as the complications could be averted.

These findings also demonstrate that patients with greater changes in their PEFR values have overall worsening disease and functional status, and also support the use of a simple peak flow meter as a useful risk stratification

tool for such patients, in addition to existing classification criteria such as GOLD criteria etc.

There are a few remarkable studies which also demonstrated the use of a simple peak flow meter in COPD patients.

Donaldson et al in his study had found that there was a greater decline in $FEV_{1,}$ and PEFR values in patients with recurrent exacerbations.[6] He, also examined the alpha value from the fluctuation analysis, and found a positive relationship between PEFR and exacerbation frequencies. In comparison, our study compared PEFR values during a routine hospital visit and during an exacerbation and found that reduced PEFR was associated with potential worse outcomes and frequent disease complications.

Studies by Ramsdale et al and colleagues have mentioned that COPD patients can have significant bronchodilator responsiveness, airway reactivity and sputum production in changes during airway resistance.[12] He also mentioned how increased sputum production may potentially increase airway resistance and affect PEFR. Hence, an early (or daily) PEFR monitoring may perhaps detect airway resistance, at an earlier stage, and treatment could be instituted early, to minimise complications. Very few studies have shown an association between airway inflammation (sputum production) and PEFR changes.[5]

In another similar study by So et al and colleagues, they also concluded that patients with COPD with greater changes in PEFR, have frequent exacerbations requiring frequent hospital admissions, reduced time to hospitalizations, and high all-cause mortality despite similar demographic, spirometry and comorbidities parameters at baseline. Daily PEFR monitoring could be helpful in risk stratification of COPD patients.[7]

The cross-sectional study by Jackson et al also concludes that PEFR is good at detecting patients with COPD, as although spirometry provides a lot of information, its relatively complex and time-consuming process, may be hindering.[10,13,14]

There were some limitations to our study. We were not able to monitor the PEFR readings, daily, of some of our patients, due to poor patient compliance and due to improper feedback. Also, since these patients were already diagnosed with COPD based on GOLD criteria, for many of these patients, we could not compare the PEFR reading with the spirometry reading, at during an exacerbation episode, again due to possible patient compliance and the clinical presentation (increased work of breathing).

Further, a histopathological study of the airways and correlating with the PEFR reading could also be done for studying at a cellular level, the mechanisms involved in airway inflammation and associating with PEFR values.

CONCLUSION

Our research study showed a significant decrease in PEFR measurements in patients with severe to very severe COPD exacerbations, which could help in earlier identification of disease progression, predict exacerbation episodes and prevent mortality.

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