ORIGINAL RESEARCH PAPER

Pulmonary Medicine

# CAN PEFR BE USED AS A SUBSTITUTE TO FEV1 IN DIAGNOSING COPD IN PRIMARY CARE SETTINGS

KEY WORDS:

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## INTRODUCTION:

Chronic Obstructive Pulmonary Disease (COPD) remains as an unrecognised public health challenge, killing more than three million premature lives yearly and accounts for 6% of the global deaths.[1] Worldwide, it is the fourth leading cause of mortality currently, which is projected to become third, by 2020. This has been attributed to the continuous rise in exposure to the risk factors of COPD.[2] The prevalence of COPD in adults ranges between 0.2% to 37%.[3] The Burden of Obstructive Lung Disease (BOLD) group recently reported an average global COPD prevalence of 10.1% with wide variations across the participating countries.[4]

Spirometry is the internationally accepted gold standard for the diagnosis of COPD.[5] It is essential in assessing the chronic airflow limitation and a post bronchodilator $FEV_1$/FVC below 0.70 confirms the diagnosis, as per Global initiative for chronic Obstructive Lung Disease (GOLD) criteria.[6] Though spirometry is a well standardized method,[7] the technical pitfalls of performing spirometry frequently limits its usage, especially in a primary health care level.[8] Peak expiratory flow rate (PEFR) can be an alternative for spirometry. The peak flow meter is more portable, operationally simple, economical and widely available.[9,10]

Despite the fact that much of the guidelines on assessment of COPD rely on spirometry values, there exists a felt need for using PEFR in areas where spirometry is not routinely available.[10] Adding to this fact, many organizational bodies focus heavily on categorizing patients based on severity of airflow limitation measured on formal pulmonary function testing, for management of COPD.[11]

It is suggested by subject experts that either $FEV_1$ or PEFR expressed as a percentage of predicted values can be used for this purpose.[9,10] However, there is no consensus on whether or not $FEV_1$% and percentage of predicted PEFR (PEFR%) can be used interchangeably in COPD patients.

Most clinicians assume a general parity between these measurements, while others oppose and opine that PEFR% may underestimate the degree of airways obstruction assessed by $FEV_1$%. Literature on the role of PEFR in severity classification of COPD is lacking. In this context, the present research has been carried out with the objective of evaluating the agreement between $FEV_1$% by spirometry and PEFR% by peak flow meter in classifying the severity of COPD as per the GOLD criteria.

## METHODOLOGY:

This cross sectional study was conducted on stable COPD patients in the department of Pulmonary Medicine of a tertiary health care center in Puducherry from a period of 18 months from October 2015 to April 2017. Adult OPD patients aged ≥ 40 years diagnosed to be suffering from COPD by GOLD criteria[6] (post bronchodilator $FEV_1$ / FVC < 0.70) with no exacerbation of their symptoms within six weeks prior to enrolment were included in the study. Those with active pulmonary tuberculosis, known asthmatics, presence of a family history of asthma, or those unable to perform peak flowmetry and spirometry satisfactorily were excluded.

The study variables included demographic profile of the study subjects, symptomatology, smoking index or biomass fuel exposure, comorbid conditions, body mass index, pre and post bronchodilator PEFR with the corresponding % predicted, pre and post bronchodilator spirometry ($FEV_1$, FVC, $FEV_1$ / FVC ratio) with the corresponding % predicted.

The study subjects satisfying the inclusion criteria were explained about the purpose of the study and informed written consent was obtained from them before the start of the study. Instructions were explained to them in their regional language regarding appropriate usage of the instruments for collecting spirometry & PEFR readings as per ATS guidelines.[13] Spirometry measurements including those of reversibility tests were estimated using a standardized spirometer (Easy One Pro®ndd Medical Technologies, USA) by a trained technician.

Peak expiratory flow rate of all the study subjects was measured by the principal investigator using a peak flow meter (Breathe-o meter™, Cipla Ltd., India). The investigator was blinded to the corresponding spirometry reading of the patient. Percentage predicted PEFR was calculated using equations applicable for Indian population. Both $FEV_1$ and PEFR were obtained from the same patient in a single visit to avoid any diurnal or day-to-day variability.

For the purpose of testing reversibility, inhaled beta agonist (400 mcg of salbutamol) was administered to the study subjects 20 minutes after the initial testing. Absence of improvement of 12% or more and 200 ml or more in post bronchodilator $FEV_1$ was taken as absence of reversibility. Post bronchodilator $FEV_1$, FVC and PEFR measurements were recorded in all study subjects. The percentage predicted PEFR was calculated using equations applicable for Indian population.[14] The severity of COPD of the subjects was classified as mild, moderate, severe or very severe as per GOLD guidelines.[6]

The collected data was entered in Epidata version 3.1, analyzed using SPSS version 17.0. The results were presented in appropriate tables and figures. Continuous variables were represented in mean and standard deviation, while categorical variables were represented in percentages. The severity of COPD classified using $FEV_1$ and PEFR was compared using Fischers' exact test. Comparisons of the measurements between $FEV_1$ and PEFR was done using paired Students t-test. Pearson's correlation was used to examine the relationship between $FEV_1$ and PEFR. Kappa statistics was employed for the agreement of the severity

between $FEV_1$ and PEFR.

**RESULTS:**

About 200 patients who fulfilled the inclusion criteria were recruited as study subjects. The mean (SD) age of the study participants was 56.6 (±10.8) years. A large proportion of them were men (69.5%) and were aged below 60 years (64.0%). Among 200 study subjects, 137 were ever smokers, inclusive of 133 former smokers and 4 current smokers. The mean (SD) smoking index among current smokers was 282.3 (±100.4) while it was 351.4 (±126.5) among former smokers. There were no female smokers in the study population. About 59 subjects (29.5%) had a history of exposure to biomass fuel, while 11 (5.5%) had obstructive airway disease post tuberculosis. The mean (SD) body mass index of men was 22.7 (±5.0) while that of women was 24.1 (±5.6). Almost half (50.5%) of the participants had breathlessness which was of mMRC grade 2, while one third of them (33.0%) had grade 3 dyspnoea. (Table 1)

Post bronchodilator spirometry and PEFR measurements of all the study subjects are depicted in Table 2. Among the 200 participants, the mean (SD) $FEV_1$/FVC ratio was 60.53 (±8.80). The mean (SD) $FEV_1$ % predicted was 54.28 (±18.47) while the mean (SD) FVC % predicted was 64.09 (±19.16). The PEFR was measured on the same sitting using mini - Wrights peak flow meter which revealed that the mean (SD) PEFR of the study population was 214.10 (±92.16) liters/minute, while the mean (SD) PEFR % predicted was 56.08 (±19.04).

The severity of airflow obstruction of the study subjects was classified as per GOLD criteria. On the basis of $FEV_1$ % predicted, a vast majority of them were either in grade II (48.5%) or grade III (34.0%) severity. Similarly, classification of the severity of obstruction using PEFR % predicted revealed that 47.0% of them had grade II and 34.0% had grade III obstruction. The proportion of grade IV obstruction using $FEV_1$ was 8.5% while it was 7.5% using PEFR % predicted. When the severity of airflow obstruction was compared using $FEV_1$ % predicted and PEFR1 % predicted, there was a significant association observed between both the parameters in grade II ($p$=0.002), grade III ($p$=0.001) and grade IV ($p$=0.002) severity. But the same could not be established in grade I severity ($p$=0.831). (Table 3)

Pearson's correlation also revealed that there existed a strong positive correlation overall between $FEV_1$ and PEFR ($p<0.001$), as observed in Figure 1.

**DISCUSSION:**

This cross sectional study was conducted in a tertiary care centre in Puducherry to evaluate whether Peak Expiratory Flow Rate can be used as a surrogate marker for Forced Expiratory Volume in the first second in classifying the severity of airflow obstruction in 200 COPD patients. Among these patients, the male:female ratio was observed to be 2.2:1.0. A morbidity survey conducted in urban areas of Patna observed that the prevalence of COPD among men was 2.12% while it was 1.33% among women, close to our findings.[15] Similarly, Thiruvengadam *et al* observed that 1.9% of males and 1.2% of females in their study were suffering from chronic airway obstruction.[16] Whereas studies conducted in other parts of the nation have observed a higher prevalence ranging upto 22% in men and 19% in women.[17] Possible reason for this difference can be methodological issues, study tools utilised in corresponding studies, or variables used for diagnosis of the disease. Nevertheless, the proportion is observed to be higher among men as compared to women.

Proportion of smokers in our study population was observed to be 68.5%. Role of smoking as a risk factor has been well established in the past. The population attributable fraction of smoking as a cause for COPD has been reported to be 76%, while some other authors observed it to be up to 97%.[18,19] Bhome AB in his study found that smokers were thrice at risk of developing COPD as compared to non smokers. Moreover, bidi smokers were found to be affected more (8.2%) as compared to their cigarette smoking counterparts (5.9%).[20] Results by Parasuramulu *et al* revealed a higher prevalence of COPD among smokers (8.3%) compared to non smokers (3.0%).[21] Around 11 were found to be known cases of tuberculosis in our study. The longer the duration post completion of anti tubercular therapy, the longer is the possibility of developing COPD. The relative risk is 26% at five years post treatment, which rises to 41% at ten years.[22]

More than one in every four individuals in our study had evidence of exposure to biomass fuel. Literature review suggests a positive association of biomass fuel exposure and chronic airflow obstruction.[23-27] Hu G *et al* in their meta analysis concluded that biomass exposure doubles the risk of developing COPD.[28] A study from Brazil comparing the exposure to fine particulate matter from biomass fuel to that from liquefied petroleum gas observed that biomass fuel exposure led to increased respiratory symptoms, impaired lung function tests and furthering development of COPD.[29]

The present study depicted a statistically significant correlation ($p<0.001$) between post bronchodilator values of $FEV_1$ (% predicted) and PEFR (% predicted). There was also a significant association between $FEV_1$ and PEFR in overall prediction of classification of severity of COPD. But Pothirat C *et al* observed in their study that though the correlation between $FEV_1$ and PEFR was strongly significant but the agreement between the two tests were not acceptable.[30] This can possible be due to regional differences.

Literature in the past have confirmed the application of peak flow rate measurements for screening patients with COPD, and daily monitoring of them.[31-35] Iglesia F et al, in their study observed the usefulness of PEFR as a predictor of mortality in patients hospitalised for acute exacerbation of COPD.[36] A prospective study conducted among Chinese men revealed that a lower value of height-adjusted peak flow measurement was associated with increased mortality from respiratory causes, including lung cancer.[37]

It is evident from our results that if GOLD guidelines are being followed and % predicted PEFR is used as a surrogate for that of $FEV_1$, the severity of obstruction can be categorized in a large proportion of patients and could result in appropriate diagnosis and management. However, the limits of agreement were wide and resulted in a significant discordance in the severity categories of airflow limitation according to GOLD classification. These values render substitution of % predicted PEFR for % predicted $FEV_1$ in 'ruling out' or 'ruling in' the severe airflow limitation.

Strengths of the present study include recruiting only COPD patients as the study subjects, usage of GOLD criteria for comparing the two measurements in categorising the severity of airflow limitation and minimization of bias due to diurnal or day-to-day variability by measuring the readings in a single session.

This study, being conducted in a hospital setting, generalisability to other areas cannot be ensured completely, which can be a limitation. Also, changes of PEFR over time were not studied. Hence its role in monitoring the progression of disease cannot be ascertained.

**CONCLUSION:**

There was a strong positive correlation observed between % predicted PEFR and % predicted $FEV_1$ among COPD patients. There was a statistically significant association between these

two parameters in classifying the severity of airflow obstruction in grade II, III and IV, but not in grade I. Hence, peak expiratory flow rate can be used as a surrogate for forced expiratory volume in first second in moderate to severe diseases but its application is limited in mild forms of the disease.

**Table 1: Baseline characteristics of the study subjects (n=200).**

| Variable | Frequency | Percentage |
|---|---|---|
| Age group (years) | | |
| 41 to 50 | 67 | 33.5 |
| 51 to 60 | 61 | 30.5 |
| 61 to 70 | 50 | 25.0 |
| 71 to 80 | 22 | 11.0 |
| Gender | | |
| male | 139 | 69.5 |
| female | 61 | 30.5 |
| Smoking status | | |
| former smokers | 133 | 66.5 |
| current smokers | 4 | 2.0 |
| non smokers | 63 | 31.5 |
| Biomass fuel exposure | 59 | 29.5 |
| History of tuberculosis | 11 | 5.5 |
| mMRC grading of dyspnoea | | |
| grade 0 | 4 | 2.0 |
| grade 1 | 15 | 7.5 |
| grade 2 | 101 | 50.5 |
| grade 3 | 66 | 33.0 |
| grade 4 | 14 | 7.0 |

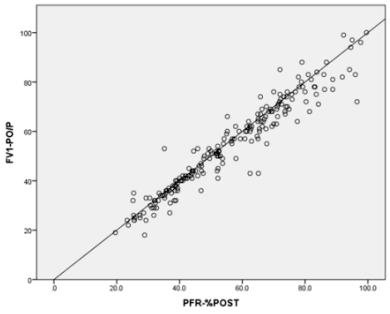
**Table 2: Post bronchodilator spirometry and PEFR measurements of study subjects (n=200).**

| Variable | Mean | Standard deviation |
|---|---|---|
| Spirometry | | |
| FEV1/FVC ratio | 60.53 | 8.80 |
| FEV1 % predicted | 54.28 | 18.47 |
| FVC % predicted | 64.09 | 19.16 |
| Peak flowmetry | | |
| PEFR (liters/minute) | 214.10 | 92.16 |
| PEFR(% predicted) | 56.08 | 19.04 |

**Table 3: Agreement between categorization of COPD severity based on FEV1 (GOLD) and PEFR (n=200).**

| COPD severity | by FEV1 (GOLD) % predicted n (%) | by PEFR % predicted n (%) | *p value* |
|---|---|---|---|
| grade I (>80%) | 18 (9.0) | 23 (11.5) | 0.831 |
| grade II (50%-80%) | 97 (48.5) | 94 (47.0) | 0.002 |
| grade III (30%-50%) | 68 (34.0) | 68 (34.0) | 0.001 |
| grade IV (<30%) | 17 (8.5) | 15 (7.5) | 0.002 |

**Figure 1: Overall correlation between FEV1 and PEFR using Pearson's correlation in the study population (n=200).**

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