Section: Respiratory Medicine

Original Research Article

A STUDY ON THE PREVALENCE OF SUBOPTIMAL PEAK INSPIRATORY FLOW AND ITS ASSOCIATED RISK FACTORS AMONG COPD PATIENTS

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Abstract

Background: Peak Inspiratory Flow Rate is a vital parameter in pulmonary medicine, indicating the highest flow rate attained during a forceful inhalation which is usually measured in litres per minute. It offers critical insights into the functionality and capacity of the respiratory muscles and airways. Suboptimal PIFR may impede medicine release from the device, resulting in suboptimal drug deposition and diminished therapeutic efficacy. This inefficient delivery may result in significant consequences, such as insufficient symptom management, increased risk of illness exacerbations, and more chances for systemic side effects due to increased oropharyngeal deposits. The aim & objective is to estimate the prevalence of Suboptimal PIFR and also to assess the patient characterstics that are related with it. **Materials and Methods:** This retrospective observational study was conducted in the department of pulmonary medicine in a tertiary care hospital for a period of one year. 255 COPD patients who attended the department during the study period. and their Data was extracted from the records stored in the department. Respiratory parameters like PIFR, FEVI, FVC, FEF, PEF, FET etc were measured using a spirometer and from the Spirometric PIFR, the diskus PIFR was calculated. Institutional ethical committee approval was obtained before conducting the study. **Result:** No The prevalence of suboptimal PIFR is 86.27% among the COPD patients. Age showed a significant association, with a higher proportion (55.9%)of participants >60 years showing Suboptimal PIFR. Male participants were more likely to have Suboptimal PIFR (60.9%). Height also had a significant impact, as 86.8% of those shorter than 165 cm show suboptimal PIFR. **Conclusion:** Suboptimal PIFR is very common among the COPD patients and the factors like age, sex, height, and BMI are critical factors influencing PIFR in COPD patients.

INTRODUCTION

Inhalers are essential for managing numerous respiratory disorders, including asthma and chronic obstructive pulmonary disease (COPD), by administering drugs directly to the airways. But, achieving the maximal therapeutic benefit is dependent upon the correct inhaling method, especially when utilizing dry powder inhalers (DPIs). To successfully receive a dose, users must inhale with sufficient flow to surpass the device's internal resistance, resulting in the disaggregation of the drug powder. The internal resistance fluctuates based on device design, and hence, the necessary flow to surmount the internal resistance also changes. Peak Inspiratory Flow Rate (PIFR) is a vital parameter in pulmonary medicine, indicating the highest flow rate attained during a forceful inhalation which is usually measured in liters per minute.[1] It offers critical insights into the functionality and capacity of the respiratory muscles and airways. This simple, non-invasive metric influences the efficacy of inhaled drugs, guaranteeing optimal drug administration. In addition to its clinical value, PIFR can assist in evaluating the advancement of pulmonary illnesses over time. Assessment of this PIFR is rather difficult as it cannot be measured directly. The internal resistance of the instrument can affect PIFR measurement. A device with lower resistance will yield a higher PIFR for a given pressure gradient compared to a device with higher resistance.[1] The optimal way to measure PIFR value is to use a in check device along with the inhaler. Due to the non-availability and the cost constraints of using this device, the alternate method adopted usually is to utilize the lung function metrics derived from

baseline spirometry as it is shown correlate linearly with the calculated Diskus PIFR.[2] Various factors like Age, gender, lung compliance, airway resistance, and inspiratory muscle strength greatly affect PIFR levels. Suboptimal PIFR may impede medicine release from the device, resulting in suboptimal drug deposition and diminished therapeutic efficacy. This inefficient delivery may result in significant consequences, such as insufficient symptom management, increased risk of illness exacerbations, and more chances for systemic side effects due to increased oropharyngeal deposits.[3] Therefore, it is essential to understand the prevalence of suboptimal PIFR and identify the patient characteristics that are associated with it in order to optimize inhaler therapy. Hence this study is conducted to estimate the prevalence of Suboptimal PIFR and also to assess the patient characteristics that are related with it.

MATERIALS AND METHODS

This was a retrospective observational study conducted in respiratory medicine department of a tertiary care hospital for a period of 1 year from October 2023 to October 2024. The sample size calculated was 255. The study participants included all the COPD patients who attended the department either as outpatient or inpatient during the study period. Data was extracted from the records of the patient stored in the department. Patients who were terminally ill were excluded from the study. Patients who had active tuberculosis, undergone thoracic surgery, bronchial asthma, interstitial lung disease, pregnant women and using nebulizers were excluded from the study. A semistructured prevalidated questionaire was employed for the collection of demographic data including age, sex, Height, weight, BMI etc. The patients were categorized according to the GOLD criteria. Respiratory parameters like PIFR, FEVI, FVC, FEF, PEF, FET etc were measured using a spirometer with strict adherence to the protocol by the researcher. From the Spirometric PIFR, the diskus PIFR was calculated using the formula 2.

$PIFR_{Diskus} = 0.139* PIFR_{spiro} – 0.257* Age +47.696$

Based on the previous studies, The PIFR cutoff value of rate 60L/min was considered as optimal and the PIFR values less than that were considered as Suboptimal.[2]

Data analysis: The collected Data was entered in MS excel sheet and analyzed using SPSS software. Continuous variables were represented as mean and standard deviation. Categorical variables were represented in frequencies and percentages. Chi square test was used to determine the significance of the association between two categorical variables. Student‘t’ test was used to determine the significance between the association between a continuous variable and a categorical variable with two categories. p value less than 0.05 was considered significant.

Ethical Considerations: Institutional ethical committee approval was obtained before conducting the study. Informed written consent was obtained from the patients included in the study.

RESULTS

The study included 255 participants with COPD and their respiratory parameters were analyzed. Figure – 1 shows the distribution of COPD patients included for the study according to the GOLD criteria. Majority of them (41.56%) were in the moderate category (GOLD 2). Figure 2 shows that among the 255 participants, 220 had PIFR < 60 L/min, while 35 had PIFR > 60 L/min and hence the prevalence of suboptimal PIFR is 86.27% among the COPD patients.

Table 1: Distribution of the demographic characters of the study participants.

COPD Patients		Calculated discus PIFR < 60		Calculated discus PIFR > 60		P value*
		(n= 220)	%	(n= 35)	%	
Age	< 60 years	97	44.1	24	68.6	0.007
	>60 years	123	55.9	11	31.4	
Sex	Male	134	60.9	30	85.7	0.004
	Female	86	39.1	5	14.3	
Ht	< 165 cm	191	86.8	20	57.1	< 0.001
	>165 cm	29	13.2	15	42.9	
BMI	< 18.5	45	20.5	4	11.4	0.01
	18.5 – 24.9	103	46.8	26	74.3	
	25 – 29.9	50	22.7	5	14.3	
	>30	22	10	-	-	
Hospital visit	IP	86	39.1	14	40	0.91
	OP	134	60.9	21	60	

Table 2: Distribution of the respiratory parameters and the changes after bronchodilation

COPD patients		Calculated discus PIFR < 60		Calculated discus PIFR > 60		P value*
		(n= 220)	%	(n= 35)	%	
FVC discordance	Increased	165	75	20	57.1	0.08
	Decreased	51	23.2	14	40	
	No change	4	1.8	1	2.9	
FEV1 Discordance	Increased	180	81.8	32	91.4	0.15
	Decreased	37	16.8	2	5.7	
	No change	3	1.4	1	2.9	

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FEF 25-75% discordance	Increased	166	75.5	32	91.4	0.05
	Decreased	48	21.8	3	8.6	
	No change	6	2.7			
PEF Discordance	Increased	162	73.6	25	71.4	0.78
	Decreased	58	26.4	10	28.6	
	No change					
FET discordance	Increased	92	41.8	13	37.1	0.28
	Decreased	107	48.6	21	60	
	No change	21	9.5	1	2.9	
FIVC discordance	Increased	157	71.4	19	54.3	0.05
	Decreased	59	26.8	16	45.7	
	No change	4	1.8			
PIFR discordance	Increased	163	74.1	14	40	<0.001
	Decreased	55	25	21	60	
	No change	2	0.9			

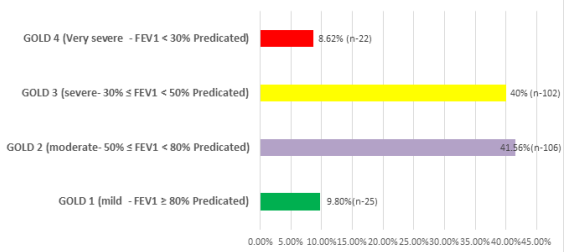

Figure 1: Distribution of COPD patients according to GOLD criteria.

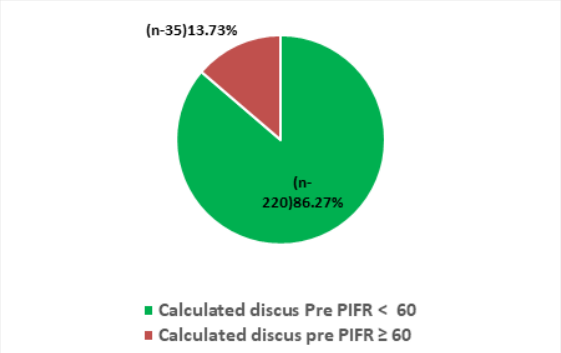

Figure 2: Distribution of Suboptimal PIFR among the study participants

The [Table 1] presents the association between various demographic and pulmonary function parameters with pre-inspiratory flow rates (PIFR) in COPD patients, categorized into two groups: those with PIFR < 60 L/min and PIFR > 60 L/min Age showed a significant association, with a higher proportion (55.9%) of participants >60 years showing Suboptimal PIFR (PIFR <60 L/min) compared to those <60 years (44.1%; p=0.007). Male participants were more likely to have Suboptimal PIFR (60.9%) than females (39.1%; p=0.004). Height also had a significant impact, as 86.8% of those shorter than 165 cm show suboptimal PIFR compared to only 13.2% in the group of participants with height more than 165 cm (p<0.001). BMI demonstrated a strong association, with 74.3% of individuals with normal BMI (18.5–24.9) achieving PIFR > 60, while those underweight (<18.5) or overweight (25–29.9) were less likely to reach optimal PIFR (p=0.01). Table 2 shows the respiratory parameters assessed using spirometry and the changes after bronchodilation. PIFR discordance was only significant as it increases after bronchodiltion in the suboptimal group. FVC discordance showed no significant difference between groups (p=0.08), though increased FVC was more prevalent in both groups. FEV1 discordance similarly lacked significant association (p=0.15), though increased FEV1 was common. Conversely, FEF 25-75% discordance was marginally significant, with increased values observed in 91.4% of the PIFR > 60 group (p=0.05). PEF discordance showed no statistical difference (p=0.78). FET discordance, although not significant (p=0.28), revealed a higher prevalence of decreased values in the PIFR > 60 group (60%). FIVC discordance was borderline significant (p=0.05), with decreased FIVC seen more often in those with PIFR > 60 (45.7%).

DISCUSSION

This retrospective observational study was conducted in the department of pulmonary medicine in a tertiary care hospital for a period of one year to assess the prevalence of suboptimal PIFR and to find out the associated factors for the suboptimal PIFR. The study included 255 COPD patients and the parameters were compared. The prevalence of Suboptimal PIFR in COPD patients was found to be 86.27% among COPD patients in our study. This prevalence was higher than previous studies. Mahaptra et al in India have reported the prevalence of sub optimal PIFR among COPD patients as 45%.[4] Harb et al in their study observed a prevalence of 44.44% of sub optimal PIFR among COPD patients.[5] This difference in the prevalence rates can be due to the differences in the inclusion of participants with varied severity. In addition to that, Most of the studies have estimated the PIFR values using the In check Dial devices whereas in our study, the Diskus PIFR was estimated using the Spirometric values. Though the linear relationship has been proven, minor differences in calculating the absolute values of PIFR can also have resulted in Overestimation of suboptimal PIFR in the COPD patients. In our study, Age was found significantly related to suboptimal PIFR with older age (more than 60 years) showed increased prevalence. This was consistent with the observations of Arawomo et al,[6] who observed increased prevalence in older age. Gosh et al also

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observed a similar finding in their study.[7] Regarding Gender, Suboptimal PIFR was more common in male patients with COPD than in Female patients in our study. But the previous studies have shown increased prevalence of suboptimal PIFR in female gender. Gosh et al in the study reported a high prevalence in females.[7] Duarte et al and sharma et al also showed increased prevalence among females.[8,9] This difference can be attributed to the unequal distribution of males and females in the groups. The other parameters that were found significantly related with suboptimal PIFR in our study were height and BMI. Short stature was found to significantly related to the suboptimal PIFR which was consistent with the finding of other studies.[1,8] Similarly BMI levels of 18.5 to 24.9 had an increased prevalence. Similar result was reported by Moon et al which showed higher prevalence with BMI of similar range.[10] Other respiratory parameters like FVC, FEV1, FEF, were not significantly related.

The major limitation of the study is that the PIFR values were calculated from the Spirometric parameters which could have overestimated the suboptimal levels. As the follow up of the patients was not done, the PIFR findings at various stages of the disease could not be calculated which could have provided further insights regarding the suboptimal PIFR values.

CONCLUSION

This study that aimed to investigate the prevalence of suboptimal PIFR (<60 L/min) and its association with various patient characteristics in individuals with COPD observed that Suboptimal PIFR is very common among the COPD patients and the factors like age, sex, height, and BMI are critical factors influencing PIFR in COPD patients. Further research is warranted to investigate the impact of interventions aimed at improving PIFR, such as inhaler technique training and device selection, on medication delivery and clinical outcomes in this population.

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