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The determinants of incorrect inhaler use in patients with obstructive airway disease

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Abstract

Inhaler therapy is the standard treatment for obstructive airway disease. Even in today's world, it is very challenging to utilize this therapy optimally. Errors in inhaler technique are very common. Identifying the errors is the first step towards correction to improve the disease. This is a cross-sectional observational study conducted at **AIMS**, Mohali, where 212 patients on inhaler therapy were enrolled who were diagnosed with asthma or chronic obstructive pulmonary disease or post-tuberculosis lung disease. The inhaler technique was assessed by a 5-point inhaler technique checklist by the clinician during the OPD visit. A multivariate binomial regression analysis was performed to calculate the crude and adjusted odds ratio of at least 1 error in inhalation technique and other covariates, including age, gender, education, profession, device, duration, and diagnosis. Among 212 enrolled patients, 135 adults (18-60 yrs) and 77 elderly (>60 years) were analyzed. Elderly [$p<0.001$; adjusted odds ratio (AOR) 8.12], unemployed ($p=0.016$), more than 5 years of inhaler use ($p=0.005$; AOR 9.54) and metered dose inhaler ($p<0.001$; AOR 5.86) had more chances of committing at least 1 error in inhaler technique. Identifying and correcting the errors in inhalational technique is the easiest and cost effective method to decrease the exacerbations and improve disease control in patients suffering from OAD by further decreasing the healthcare burden.

Key words: inhaler technique, MDI, DPI, errors, asthma, COPD.

Introduction

Inhaler therapy is the cornerstone in the management of the Obstructive airway diseases (OAD) which mainly includes Asthma and COPD. Inhaled drugs directly reach the distal airway for rapid symptom relief and optimum disease control with fewer side effects when compared with systemic drugs [1]. Inhaled drugs are the best way forward for airway diseases but still the adherence to the therapy is very low as implementation of proper inhaler technique has many challenges. Incorrect technique leads to less symptomatic improvement, less disease control which further decreases the adherence. Knowledge of correct inhaler technique among health care professionals has also received less than required attention [2]. Correct inhaler technique is crucial for optimum drug delivery in the airway for required disease control and symptom relief [1]. Moreover, less confidence in the inhaler treatment is another barrier for adherence to the treatment [2]. Hence, patient education is the essential component for the management of OAD. Adequate technique provides optimum symptom relief and prevents exacerbations [3]. As per the current evidence, 45-60 % of the patients commit at least 1 error in inhalation technique [4,5]. Available data on Indian population is scarce and considering the difference in health literacy, education status and resources, western studies cannot be generalised to Indian population.

This study analysed the stepwise errors in the inhaler technique in patients with OAD and the association of various patient factors with these errors. Identification of common errors can help train the healthcare worker better and reinforce correct technique for better disease control and quality of life which will further increase acceptance of the inhaled therapy. Improvement in inhaler acceptance will further decrease economic burden on the healthcare system.

Material and Methods

Study design

Cross sectional observational study design.

Study settings

The study was conducted at Respiratory Medicine OPD at AIMS, Mohali. In the OPD, patients were asked to demonstrate their inhaler device when they visited the OPD for regular follow up or during first visit if already on inhalers for the diagnosis of Asthma or COPD or PTLT (Post TB lung Disease).

Study population

The patients visiting Respiratory Medicine OPD at AIMS, Mohali during the time period of 2 January 2025 to 1 January 2026 and on inhalers for obstructive airway disease for at least 1 month were enrolled. Patients with the diagnosis of Asthma, PTLT and COPD were included. Clinical diagnosis was made on the basis of suggestive history, examination and CXR. Diagnosis of Asthma was made on the basis of variable respiratory symptoms and rhonchi on auscultation along with a normal CXR. For the diagnosis of COPD, smoking or household smoke exposure was confirmed by the history from the patient along with either rhonchi or decreased breath sounds on examination and emphysema on CXR or CT scan. PTLT was diagnosed on the basis of history of past Pulmonary TB and chronic respiratory symptoms after that event and rhonchi on examination. Inhaler technique was assessed at the OPD visit. Patients were asked to demonstrate the inhaler technique with their own device. It was ensured from the history that Inhaler technique was taught to them by any healthcare worker eg. Nurse or PFT Technician or Intern or Resident or Clinician in the past. Patients on Dry powder inhaler (DPI) or metered dose inhaler (MDI) or MDI with spacer, breath actuated inhaler (BAI) were enrolled. 5 point Inhaler technique checklist [2] (Table 1) was used depending on the device used by the patient. Repeat inhalation was not included in the study as it is not required in MDI. Errors in the inhaler technique were noted and correct technique was explained to the patient if found incorrect. Mouth rinse after inhaler use was explained to all the patients.

Inclusion criteria

1. Already on inhaled drugs by either MDI or DPI or BAI for at least 1 month.
2. > 18 years of age

3. Inhaler technique has been taught to them by healthcare worker in hospital settings.
4. Clinically diagnosed case of BA/COPD/PTLD

Exclusion criteria

1. Active pulmonary Tuberculosis
2. Respiratory failure
3. Psychiatric illness
4. Arthritis

Data collection (Figure 1)

The demographic details of all the patients were taken from the OPD registration slip. Educational qualification, occupation, history of TB, symptom duration and treatment history were enquired from the patient. In the OPD setting, patients were asked to demonstrate the inhaler technique which was directly observed by the clinician [4] and the correct technique was explained to the patient. Structured proforma was filled for each patient which included demographic details, treatment history and steps of inhalation technique. Excel sheet was prepared including all the variables. Monthly data checks were done to ensure data accuracy and credibility.

Sample size and sampling

Based on prior literature indicating error rates of approximately 60% in similar settings with confidence interval of 95%, 10% margin of error and power of 80%, the sample size calculated was approximately N= 220. A consecutive sampling method was used till the target sample was reached.

Statistical analysis

All data was collected by the treating pulmonologist at the time of the OPD visit. It was analysed by version 21.0 of SPSS software. For all statistical analysis, 95% confidence interval was used to describe the effect size. All the data was assessed for missing data or duplicate and normality manually. Non parametric tests were used for categorical data

and reported as absolute values and percentages. A multivariate binomial regression analysis was performed to calculate the crude and adjusted odds ratio of at least 1 error in inhalation technique and other covariates included age, gender, education, profession, device, duration and diagnosis. P value of <0.05 was considered as significant for all statistical analysis.

Ethical consideration

Patients were offered standard treatment as per the guidelines. This study did not include any new intervention. Consent was taken by each patient before enrolment and there was no additional cost to the patient. Ethical approval was taken by institutional ethical committee vide IEC number- AIMS/RPAB/2022/22 dated 3 August 2022. Ethical standards as per declaration of Helsinki were strictly followed.

Results

Age (Table 2) –135 adults (18-60 yrs) and 77 elderly (>60 years) were enrolled in the study. Elderly committed more mistakes when compared with adults. Age is a statistically significant factor for inadequate inhaler technique (p value <0.001). Elderly have 8.12 times higher adjusted odds of making at least 1 error while using inhaler devices as compared to adults.

Gender- The study enrolled more females (121, 57.1%) as compared to males (91, 42.9%). However the association with gender is statistically insignificant.(p value 0.344)

Education- The inhaler errors are inversely related to the level of education. With increasing education, error rates are declining whereas after adjusting for various determinants, the p value remains insignificant (0.154).

Profession- Students (11, 5.2%), skilled (48, 22.6%) and even unskilled workers (69, 32.5%) are less likely to commit errors when compared with homemakers and unemployed population (84, 39.6%). Unemployed study participants were more likely to commit errors in inhaler therapy (p value 0.0016).

Inhaler duration- The duration of use of inhaler significantly impacts the chances of making errors (p value 0.005). As per the study, patients using the devices for longer

durations have more odds of committing errors. Patients who have been using inhalers for more than 5 years have 9.54 times higher adjusted odds of making inhaler error.

Diagnosis- The patients diagnosed with Asthma (143, 67.5%), COPD (59, 27.8%) and PTLD (10, 4.7%) were included in the study. The diagnosis was statistically insignificant (p value 0.781) for evaluating error in inhalational technique. Most of the patients were on formoterol budesonide combination (154, 72.6%). Only 11(5.2%) were on levosalbutamol, (23, 10.8%) on glycopyrronium formoterol combination, (5, 2.4%) on tiotropium and (16, 7.5%) on triple combination.

Device – The type of device remains a strong determinant for inhaler technique proficiency. MDI (66, 31.1%) are significantly associated with more errors when compared with DPI (136, 64.2%) or breath actuated with a p value of <0.001. Patients using MDI devices are 5.86 times more likely to commit an error. . Number of patients using BAI (10, 4.7%) was very less although they have lesser odds of making an error. Patients using MDI with a spacer (n = 3) were excluded from the analysis as this represented a distinct subgroup and could have introduced heterogeneity and potentially influenced the study findings.

Stepwise errors (Figure 2) - Out of all, 171(80.6%) patients had errors in inhalational technique. 30(14.2%) patients did all 5 steps wrong whereas only 41(19.3%) had perfect technique. Step 2 (breathe out) followed by Step5 (breath hold) were the most common errors.

Discussion

Although, Inhalational therapy is the evidence based standard therapy for OAD as it has direct reach to the airway eluding systemic absorption but practically in the real world it is not achieved due to various reasons. Firstly, acceptance to the inhalers is very poor especially in low middle income countries where education is directly linked with better acceptance and less error rate. Patients with low level of education are likely to make more errors [4-7]. In Patients with longer duration of inhaler use, the effect of education or training is lost over years [4]. The rate of error is not directly related to prior inhaler exposure but definitely with prior training by a doctor [8] . That's why it's pertinent to

check inhaler technique in every OPD visit but surprisingly, adherence is very low. It is time consuming but a cost effective way of decreasing burden on the healthcare system and patient related morbidity. In this study, older age group showed more errors which can be attributed to various co-morbidities, declining cognitive function, lip seal issues and less acceptance [9]. In the current study, no association was found between gender and inhalation technique error which is supported by various other studies [4,8].

Secondly, the prevalence of errors is very high which leads to insufficient drug deposition in the airways. Wrong inhaler technique leads to poor disease control and poor adherence to the treatment [10]. As per the previous studies and meta-analysis, error rate ranges from 65.5-93.7 % which further stresses upon the need for regular monitoring of the inhaler technique during every healthcare visit [3,4,5,6,8,11,12]. Breathe out was the most common step performed wrongly [3,5,8,11,12]. While making the choice for the inhaler device, important consideration should be given to the patient preference which is directly related to the cost, size and ease of using the device. For the clinicians, drug deposition and errors are more important considerations than the above [13]. MDI are associated with more errors as compared to DPI. Coordination remains a significant problem with MDI devices [6,7,12] whereas in DPI forceful inhalation is ensured by the patient himself by the noise produced from the capsule during step 4. Disease severity has strong impact on the inspiratory effort of the patient. Selection of right inhaler device plays a pivotal role in symptom control and adherence to the therapy [13]. MDI requires slow and steady inhalation compared to quick and deep inhalation in DPI [14]. MDI require coordination and DPI require high inspiratory flow rate, MDI with spacer overcomes both the problems [15]. It is noteworthy that drug deposition differs significantly in both the devices. MDI delivers nearly double the amount of drug to distal airways as compared to DPI when taken correctly [16]. Eventually, MDI are associated with more errors whereas, the drug deposition of MDI is far better than DPI. Hence, the standard most effective device remains MDI with spacer. For, MDI, the proper technique must be ensured at every visit whereas for DPI good inspiratory flow is the prerequisite. To conclude, the patient should be counseled regarding the available device options and shared decision should be made respecting and incorporating the patients preference [17].

Strengths and limitations

The biggest strength of the study was that the data collection was done by a single pulmonologist avoiding inter observer bias. One of the main limitation especially for the diagnosis of COPD was that the diagnosis of OAD was clinical and spirometry was not performed. Secondly, the disease severity or past exacerbation has direct association with errors [5]. Future studies can compare errors with CAT score and number of exacerbations to develop evidence for better treatment and prognosis. Thirdly, the study population was heterogeneous and inhaler acceptance is different in these diseases. It can impact the likelihood of errors.

Implication for public health

These errors are alarming especially when the world is already dealing with an increasing burden of OAD due to industrialization, pollution, urbanization. Errors in inhalational therapy if identified and corrected can definitely lead to better prognosis and decreased exacerbations in OAD decreasing the economic burden to the patient and healthcare system. Training of healthcare professionals should be done on regular basis at all the levels of healthcare. Correct technique must be ensured at every OPD visit for which patients must be advised to bring the device along. A standard checklist for inhaler technique must be available at all healthcare [19].

Conclusions

Identifying and correcting the errors in inhalational technique is the easiest and cost effective method to decrease the exacerbations and improve disease control in patients suffering from OAD by further decreasing the healthcare burden.

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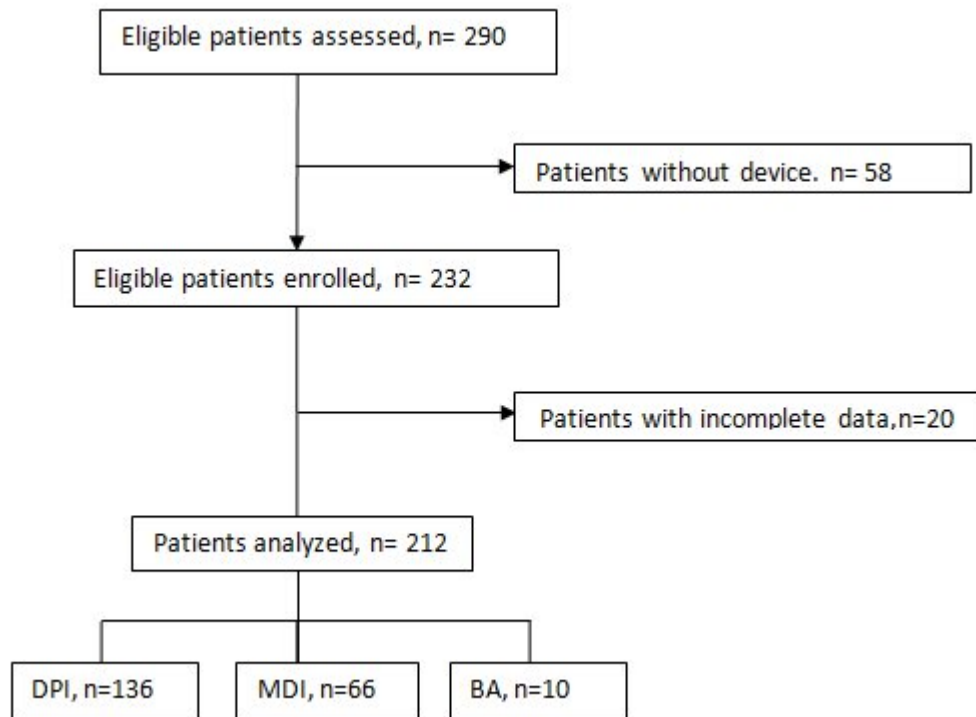


Figure 1. Data collection flow chart.

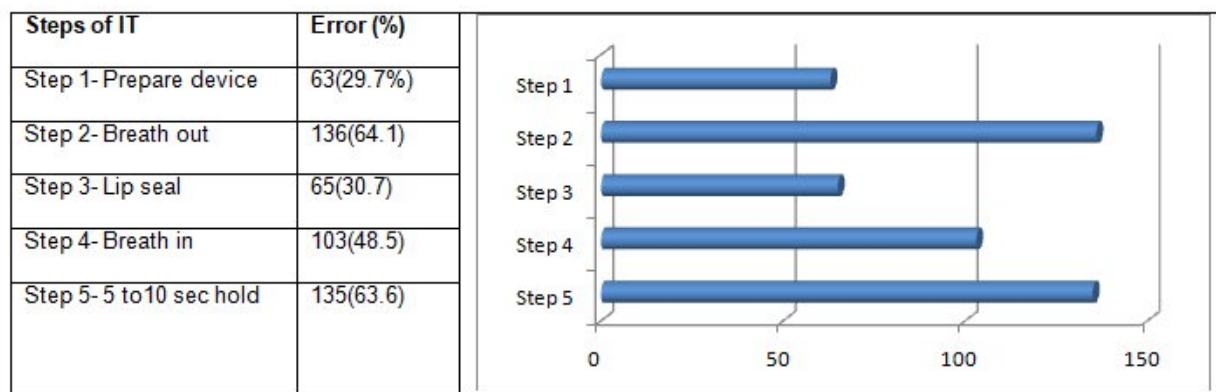


Figure 2. Frequency of errors in the patients of OAD and the bar diagram of error frequency at different steps of inhaler technique.

Table 1. Steps of inhaler technique.

Steps of inhaler technique	
1. Prepare	Shake the device in MDI and insert capsule and break it for DPI
2. Breath out	Fully and gently
3. Lip seal	No air leak from sides
4. Breath in	Slow and steady in MDI and Quick and deep in DPI
5. 5-10 sec hold	Hold breath before exhaling

Table 2. Characteristics of the patient with OAD making at least one error and patients making no error and multivariate logistic regression analysis to evaluate the determinants of inadequate inhaler technique.

Variable	Sub category	N=212	No error	At least 1 error	p (Chi-Sq)	COR(95%CI)	AOR(95%CI)
Age	Adult	135	37	98	<0.001	1.00 (reference)	1.00 (reference)
	Elderly (>60 years)	77	4	73		9.13 (2.72-30.66)	8.12 (2.38-27.63)
Gender	Female	121 (57.1)	20	101	0.344	1.00 (reference)	1.00 (reference)
	Male	91 (42.9)	21	70		0.75 (0.37-1.53)	0.74 (0.32-1.69)
Education	Illiterate	92 (43.4)	12	80	0.154	1.71 (0.49-5.97)	1.47 (0.40-5.41)
	Primary	40 (18.8)	8	32		1.06 (0.28-4.05)	1.22 (0.30-4.89)
	Secondary	47 (22.2)	13	34		0.69 (0.20-2.46)	0.77 (0.20-2.87)
	Graduate	19 (9)	4	15		1.00 (reference)	1.00(reference)
	Post Graduation	14(6.6)	4	10		0.45 (0.10-2.12)	0.65 (0.13-3.18)
Profession	Homemaker/unemployed	84 (39.6)	12	72	0.016	1.00 (reference)	1.00(reference)
	Skilled	48 (22.6)	7	41		0.75 (0.28-2.02)	0.76 (0.24-2.45)
	Unskilled	69 (32.5)	14	55		0.59 (0.25-1.38)	0.44 (0.16-1.20)
	Student	11 (5.2)	8	3		0.13 (0.03-0.54)	0.11 (0.02-0.61)
Inhalers duration	1-6 months	77 (36.3)	21	56	0.005	1.00 (reference)	1.00 (reference)
	6-12 months	55 (25.9)	13	42		1.34 (0.57-3.16)	1.29 (0.51-3.28)
	1-5 years	50 (23.6)	6	44		3.38 (1.15-9.90)	3.82 (1.17-12.44)
	> 5 years	30 (14.1)	1	29		10.88 (1.37-86.13)	9.54 (1.11-81.82)
Diagnosis	Asthma	143 (67.5)	27	116	0.781	1.00 (reference)	1.00 (reference)
	COPD	59 (27.8)	13	46		0.87 (0.41-1.85)	0.94 (0.39 – 2.27)
	PTLD	10 (4.7)	1	9		2.00 (0.24-16.59)	1.84 (0.19 – 17.65)
Device	Dpi	136 (64.2)	32	104	<0.001	1.00 (reference)	1.00 (reference)
	Mdi	66 (31.1)	5	61		6.20 (1.82-21.08)	5.86 (1.64 – 20.93)
	Breath actuated	10 (4.7)	4	6		0.29 (0.008-1.12)	0.31 (0.07 – 1.34)