

Assessment of Metered Dose Inhaler Technique Errors in Chronic Obstructive Pulmonary Disease Patients: A Cross-Sectional Study

Atiq Ullah¹, Akhtar Ali Khan², Ihsan Ullah Nasir³, Khalid Jamal⁴, Muhammad Rehan⁵, Shakeel Ahmad⁶

¹⁻⁶Department of Pulmonology, Saidu Teaching Hospital, Swat

ABSTRACT

Objective: To assess the frequency of metered dose inhaler technique errors among patients with chronic obstructive pulmonary disease.

Methodology: This cross-sectional study was carried out from 8 February 2025 to 8 May 2025 in the Department of Pulmonology, Saidu Group of Teaching Hospital, Swat. A total of 91 patients aged 40–70 years were included. Patients were asked to demonstrate inhaler use and technique was assessed by using a standardised 12-step checklist. Data was analyzed by SPSS version 25. Mean $\pm$ standard deviation was calculated for quantitative variables and frequencies with percentages for qualitative variables.

Results: Mean age was 55.23 ± 8.87 years. The majority of patients were male (57, 62.6%). Overall, inhaler error was present in 86 (94.50%) patients. Only 40 (44.00%) patients had previous education. Correct performance of important steps was low, including mouthpiece placement 24 (26.40%), exhalation before inhalation 27 (29.70%) and breath holding 32 (35.20%).

Conclusion: A very high frequency of inhaler technique errors was observed among patients.

Keywords: Administration, Inhalation, Drug Administration Routes, Inhalation Therapy, Patient Education as Topic, Pulmonary Disease, Chronic Obstructive

Authors' Contribution:

^{1,2}Conception; Literature research; manuscript design and drafting; ^{3,4}Critical analysis and manuscript review; ^{5,6}Data analysis; Manuscript Editing.

Correspondence:

Akhtar Ali Khan
Email: akhtarpulmonologist@gmail.com

Article info:

Received: April 23, 2026
Accepted: August 08, 2026

Cite this article. Ullah A, Khan AA, Nasir IU, Jamal K, Rehan M, Ahmad S. Assessment of Metered Dose Inhaler Technique Errors in Chronic Obstructive Pulmonary Disease Patients: A Cross-Sectional Study. J Islamabad Med Dental Coll. 2026; 15(3): 304-310.

DOI: <https://doi.org/10.35787/jimdc.v15i3.1590>

Funding Source: Nil

Conflict of interest: Nil

Introduction

Chronic obstructive pulmonary disease (COPD) is a common and persistent respiratory disorder with the hallmark of persistent and usually progressive airflow limitation.¹ It consists of predominantly chronic bronchitis and emphysema and is strongly associated with prolonged exposure to noxious particles in the lungs, such as tobacco smoke and environmental pollution.² Individuals with this condition often present with symptoms such as

chronic cough with sputum production and dyspnea. Apart from the respiratory system, this condition also has systemic manifestations such as weight loss and wasting, as well as an increased risk of heart problems.³ The pathophysiology of this condition involves airway inflammation and mucus hypersecretion, as well as the destruction of the alveolar walls.⁴

The management of COPD is focused on the alleviation of the symptoms, improvement of the

quality of life, and reduction of the severity of the disease.⁵ This is done through pharmacological and non-pharmacological means. The pharmacological treatment of COPD includes the administration of bronchodilators like beta-agonists and anticholinergics, and inhaled corticosteroids in specific patient groups.⁶ Combination therapy is also used in the treatment of severe cases of COPD. The non-pharmacological treatment of COPD includes the cessation of smoking, the most important factor in the treatment of the disease, rehabilitation of the patient, vaccination of the patient against flu and pneumococcus, and oxygen therapy in severe cases.⁷ The inhalation therapy is the most commonly used treatment of COPD because it has fewer side effects and the drug is delivered locally with minimal systemic effects.⁸

Technique errors in the administration of a metered-dose inhaler (MDI) are common among patients with COPD and may result in reduced medication delivery, poor disease control, and increased risk of exacerbations.⁹ These errors may occur at different steps of the inhalation procedure. These errors include not shaking the inhaler before use, incorrect positioning of the inhaler, inadequate coordination of the inhalation and actuation of the inhaler, inhalation performed too quickly or too slowly, and not holding the breath after inhalation.¹⁰ In addition, not exhaling before inhalation and incorrect sealing of the lips around the inhaler are also errors in the administration of an MDI. Inadequate patient education, old age, cognitive function, and inadequate training of health care providers also increase the risk of errors.¹¹

However, there is a scarcity of local data regarding incorrect techniques in the use of a metered-dose inhaler in patients with chronic obstructive pulmonary disease in Swat, which is a significant problem due to a high rate of tobacco and biomass fuel usage in this area. Therefore, this study is important in order to assess the degree of incorrect techniques in the use of a metered-dose inhaler in patients with chronic obstructive pulmonary disease

in Swat and to reduce this problem by providing education in this regard in order to improve patient outcomes and reduce disease burden.

Methodology

This cross-sectional study was carried out in the Department of Pulmonology at Saidu Group of Teaching Hospital, Swat, from 8 February 2025 to 8 May 2025. The sample size was 91 patients, calculated at a 95% confidence level with 5% absolute precision, taking an expected frequency of incorrect metered-dose inhaler (MDI) technique as 93.7% in COPD patients.¹² The sample size was calculated using the WHO sample size calculator.

Patients were selected using a consecutive sampling technique. All eligible COPD patients presenting to the pulmonology inpatient and outpatient departments during the study period were consecutively recruited until the required sample size was achieved. This sampling method was chosen to ensure inclusion of all available eligible patients in the clinical setting and to reduce selection bias within the study population.

Patients aged 40–70 years, of either gender, who were diagnosed with COPD according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria were included.

Patients with acute exacerbation of COPD at the time of assessment, cognitive impairment or dementia preventing them from following instructions, and those with severe comorbid conditions such as advanced heart failure, severe psychiatric illness, or any other condition interfering with inhaler use or assessment were excluded.

COPD diagnosis was confirmed through available spirometry reports showing post-bronchodilator FEV1/FVC <0.70 or documented previous spirometric confirmation in medical records.

After obtaining written informed consent, patients were enrolled from both inpatient and outpatient departments of pulmonology. Each participant was asked to demonstrate their usual inhaler technique

without receiving assistance. The technique was assessed by trained pulmonology residents using a standardized 12-step MDI technique checklist.

Before initiation of data collection, all observers received training regarding the correct MDI technique assessment procedure. Training included demonstration of correct inhaler use according to standard inhaler administration recommendations and instructions on applying the checklist consistently. The same assessment procedure was followed for all participants to minimize observer-related variation.

Each step of the checklist was recorded as correct, incorrect, or not performed, and the total number of errors was calculated for each participant.

The 12-step MDI technique checklist used in this study was based on standard recommended steps for correct MDI administration. The checklist was reviewed by pulmonology experts before data collection to ensure content validity and appropriateness for COPD patients. The assessed steps included removal of the cap, shaking the inhaler, attaching the spacer when required, maintaining an upright inhaler position, complete expiration before inhalation, correct mouth positioning, simultaneous actuation and inhalation, slow and deep inhalation, breath holding for 5–10 seconds, removing the inhaler from the mouth, returning to normal breathing, and taking a second dose when required.

MDI technique was considered incorrect if the patient failed to correctly perform any of the twelve steps or performed the steps in an incorrect sequence.

All collected data were entered into a secure electronic database, and confidentiality was maintained by assigning unique patient identification numbers.

Data were analyzed using SPSS version 25. Mean $\pm$ standard deviation was calculated for quantitative variables, while frequencies and percentages were calculated for qualitative variables.

Ethical approval was obtained from the Institutional Research Board of SGTH, Saidu Teaching Hospital Swat (155-ERB-024), and synopsis approval was obtained from the College of Physicians and Surgeons Pakistan before the start of data collection.

Results

The study enrolled a total of 91 COPD patients, the mean age of the patients was 55.23 ± 8.87 years. The mean height was 163.01 ± 6.75 cm and the mean weight was recorded as 67.33 ± 10.84 kg, the BMI was found to be 25.45 ± 4.54 . Duration of MDI use among the study participants was 5.94 ± 2.31 years. In regard of gender, male patients were in majority that is 57 (62.6%) and female patients were less in number that is 34 (37.4%). Most of patients were from rural areas 58 (63.7%) and urban patients were 33 (36.3%). For socioeconomic status, majority patients belong to low socioeconomic class 49 (53.8%), middle class were 23 (25.3%) and high-class patients were 19 (20.9%). In educational background, uneducated patients were highest 42 (46.2%), primary educated were 26 (28.6%), secondary educated were 12 (13.2%) and those with higher education were 11 (12.1%). Smoking was present among 34 (37.4%) patients while non-smokers were 57 (62.6%). Biomass exposure was seen in large number of patients that is 73 (80.2%) and without biomass exposure were only 18 (19.8%). Spacer was used by 43 (47.3%) patients and 48 (52.7%) patients was not using spacer (Table-I). When previous education on MDI technique was assessed, only 40 (44.00%) patients had received education about MDI technique and more than half that is 51 (56.00%) had received no previous education at all. Among those who received education, the most common source was GPs with 21 (23.10%) patients followed by respiratory nurse which was 6 (6.60%), resident doctors were 5 (5.50%), consultant and pharmacist were equal both

3 (3.30%) each, and house officers was least that is only 2 (2.20%) patients (Table-II).

Table- I: Patient Demographics	
Demographics	Mean $\pm$ SD
Age (years)	55.23 $\pm$ 8.87
Height (cm)	163.01 $\pm$ 6.75
Weight (kg)	67.33 $\pm$ 10.84
BMI	25.45 $\pm$ 4.54
MDI Duration (years)	5.94 $\pm$ 2.31
Gender	
Male n (%)	57 (62.6)
Female n (%)	34 (37.4)
Residence	
Rural n (%)	58 (63.7)
Urban n (%)	33 (36.3)
Socioeconomic Status	
Low n (%)	49 (53.8)
Middle n (%)	23 (25.3)
High n (%)	19 (20.9)
Education	
Uneducated n (%)	42 (46.2)
Primary n (%)	26 (28.6)
Secondary n (%)	12 (13.2)
Higher n (%)	11 (12.1)
Smoking	
Yes n (%)	34 (37.4)
No n (%)	57 (62.6)
Biomass Exposure	
Yes n (%)	73 (80.2)
No n (%)	18 (19.8)
Spacer Use	
Yes n (%)	43 (47.3)
No n (%)	48 (52.7)

Table- II: Previous Education on MDI Technique Among COPD Patients		
Previous Education	Frequency	Percentage
Yes	40	44.00
No	51	56.00
Total	91	100
Source of Education		
Consultant	3	3.3
Resident	5	5.50
House Officer	2	2.20
Respiratory Nurse	6	6.60
Pharmacist	3	3.30
GP's	21	23.10

Table- III: Frequency of MDI Technique Errors Among COPD Patients		
MDI Technique Steps	Frequency	Percentage
Removing Cap from Inhaler		
Correct	33	36.30
Incorrect	45	49.50
Not done	13	14.30
Shaking Inhaler Before Use		
Correct	36	39.60
Incorrect	39	42.90
Not done	16	17.60
Attaching Inhaler to Spacer if Needed		
Correct	24	26.40
Incorrect	51	56.00
Not done	16	17.60
Holding Inhaler Upright		
Correct	39	42.90
Incorrect	39	42.90
Not done	13	14.30
Exhaling Completely Before Inhalation		
Correct	27	29.70
Incorrect	48	52.70
Not done	16	17.60
Proper Mouthpiece Placement with Lip Seal		
Correct	24	26.40
Incorrect	52	57.10
Not done	15	16.50
Actuating Inhaler During Inhalation		
Correct	42	46.20
Incorrect	34	37.40
Not done	15	16.50
Inhaling Slowly and Deeply		
Correct	34	37.40
Incorrect	37	40.70
Not done	20	22.00
Holding Breath for 5–10 Seconds		
Correct	32	35.20
Incorrect	36	39.60
Not done	23	25.30
Removing Inhaler from Mouth		
Correct	32	35.20
Incorrect	46	50.50
Not done	13	14.30
Breathing Normally After Inhalation		
Correct	31	34.10
Incorrect	46	50.50
Not done	14	15.40
Repeating for Second Puff if Required		
Correct	31	34.10
Incorrect	42	46.20
Not done	18	19.80
MDI Technique Errors		
Yes	86	94.50
No	5	5.50

Discussion

This study was conducted to assess the MDI technique errors among COPD patients and to find out the previous education status regarding inhaler use. The findings of present study were revealing that majority of patients were middle aged with mean age 55.23 ± 8.87 years and most of them were male 57 (62.6%), which is consistent with the known fact that COPD is more prevalent in males due to higher rates of smoking and occupational exposures. The incidence of metered dose inhaler (MDI) error was observed among all participants, with 86 individuals (94.50%) showing inaccuracies. This shows that the rate of error was markedly high. The worst steps were shown by 24 participants (26.40%) for attaching the inhaler to the spacer and another 24 participants (26.40%) for proper placement of the mouthpiece with a lip seal. The steps require specific coordination and understanding of the device, which is quite challenging without proper demonstration. The exhalation before inhaling was also done incorrectly by 27 participants (29.70%), and this is an important step because failing to exhale completely will reduce the volume of lungs available for medication. Similarly, proper breath hold for 5-10 seconds was correct for only 32 participants (35.20%), and this is an important step because without proper breath hold, medication will be exhaled before being deposited.

The findings of present study were showing that 86 (94.50%) COPD patients had at least one MDI technique error, which is very high rate. This result is closely similar to findings of Marko *et al.*¹³ who reported up to 94.2% patients commit at least one error, and Rahman *et al.*¹⁴ who found errors in 94.4% MDI users, suggesting that poor inhaler technique is very widespread problem regardless of geographic location or healthcare setting. Castel-Branco *et al.*¹⁵ also reported 87% patients made at least one error and Zhou *et al.*¹⁶ found pooled error rate of 76% in meta-analysis of COPD patients, though this rate was somewhat lower than present

study findings which may be because Zhou *et al.*¹⁶ included different inhaler devices like DPI and SMI in addition to MDI and some devices may have lower error rates.

Regarding previous education on MDI technique, only 40 (44.00%) patients had received any education and GPs were the most common source, accounting for 21 (23.10%) patients. This finding is consistent with recent evidence showing that structured inhaler technique education and individualized coaching can significantly improve pMDI use among COPD patients. Usmani *et al.* reported that targeted one-on-one coaching improved inhaler technique and reduced critical errors in COPD patients, highlighting the importance of regular assessment and demonstration of correct inhaler use.¹⁷ The high error rate observed in the present study may partly be explained by the fact that more than half of patients had never received formal inhaler education, while those who received education mostly relied on GPs, who may have limited time for repeated and structured inhaler demonstrations in busy outpatient settings.

Among specific technique errors, exhaling completely before inhalation was correctly done only by 27 (29.70%) patients and holding breath for 5 to 10 seconds was correct in only 32 (35.20%) patients. These findings are well supported by Ocakli *et al.*¹⁸ who reported failure to exhale before inhalation as most frequent error in 75.8% COPD patients, and Cho-Reyes *et al.*¹¹ who found failure to exhale in 65.5% and inadequate breath-hold in 41.9% patients in their meta-analysis. Castel-Branco *et al.*¹⁵ similarly found no breath-hold as major error in 62.5% pMDI users. The scientific reason for these errors is that exhaling completely is unintuitive step for patients and breath-holding require conscious effort which patients forget or find difficult, and without proper demonstration these steps is easily missed.

Proper mouthpiece placement with lip seal was correctly performed only by 24 (26.40%) patients and actuating inhaler during inhalation was correct

in 42 (46.20%) patients. Cho-Reyes *et al.*¹¹ also reported improper inhalation in 39.4% and Castel-Branco *et al.*¹⁵ found poor coordination as major error in 43.8% pMDI users which is comparable to present study. Poor coordination between actuation and inhalation is a very common and clinically important error because if inhaler is actuated too early or too late then drug deposit in oropharynx instead of reaching lower airways, this reduces therapeutic efficacy and increase side effects.

The majority of patients in present study was from rural areas 58 (63.7%) with low socioeconomic status 49 (53.8%) and uneducated 42 (46.2%), these demographic factors likely contributed to high error rate because patients with low literacy and limited healthcare access have less exposure to proper inhaler education and counseling. Ocakli *et al.*¹⁸ also found that errors were significantly associated with certain demographic factors including gender and shorter disease duration, supporting the idea that patient background characteristics influence inhaler technique performance. Overall, the findings of present study were reinforcing the urgent need for structured inhaler education programs especially in resource limited settings where patients have least access to proper training.

This study has several strengths. First, the study objectively assessed MDI technique using a standardized step-based checklist rather than relying only on patient self-report, which provides a more accurate evaluation of inhaler errors. Second, the inclusion of COPD patients from a real-world clinical setting increases the practical relevance of the findings. Third, the study highlights specific critical steps where patients commonly make errors, which can help healthcare providers design targeted inhaler education interventions. Additionally, the assessment of patient education sources provides useful information regarding current gaps in inhaler training practices and identifies opportunities for improving COPD management.

The limitations of the present study are many and need to be considered while interpreting the results.

To begin with, the study is carried out in one hospital and may not be representative of the general COPD population in the country. Secondly, the sample size is 91, which may not be sufficient to represent the general COPD population. Thirdly, the cross-sectional study allows evaluation at only one point in time and may not be sufficient to determine the relationship between different variables. Observer bias is also a possibility in this study, as the evaluation of MDI technique is done by observing the patients. It is possible that the performance of the patients may be affected because of the observer effect. Moreover, the study is based on self-reported data such as smoking and biomass exposure, which may be subject to recall bias.

Conclusion

The present study found that the majority of patients with chronic obstructive pulmonary disease (COPD) used the metered dose inhaler (MDI) device incorrectly, with a significant proportion of patients committing at least one error in the administration of the MDI device. It was also found that the previous education received by the patients regarding the MDI device was inadequate for more than half of the patients, with general practitioners being the most common source of MDI instruction, although not necessarily the best one.

Acknowledgment:

The author thankful to all medical staff of the department for their continuous support and effort. Their proper maintaining of patient records and organized data handling helped a lot in completion of this study.

References

1. Celli B, Fabbri L, Criner G, Martinez FJ, Mannino D, Vogelmeier C, *et al.* Definition and nomenclature of chronic obstructive pulmonary disease: time for its revision. *Am J Respir Crit Care Med.* 2022;206(11):1317-1325. DOI: <https://doi.org/10.1164/rccm.202204-0671PP>

2. Li Y, Yan F, Jiang L, Zhen W, Li X, Wang H. Epidemiological trends and risk factors of chronic obstructive pulmonary disease in young individuals based on the 2021 global burden of disease data (1990-2021). *BMC Pulm Med*. 2025;25(1):174. <https://doi.org/10.1186/s12890-025-03630-z>
3. Xiang Y, Luo X. Extrapulmonary comorbidities associated with chronic obstructive pulmonary disease: a review. *Int J Chron Obstruct Pulmon Dis*. 2024;19:567-578. <https://doi.org/10.2147/COPD.S447739>
4. Rodrigues SO, Cunha CMCD, Soares GMV, Silva PL, Silva AR, Gonçalves-de-Albuquerque CF. Mechanisms, pathophysiology and currently proposed treatments of chronic obstructive pulmonary disease. *Pharmaceuticals (Basel)*. 2021;14(10):979. <https://doi.org/10.3390/ph14100979>
5. Halpin DMG, Singh D. What's new in the 2025 GOLD report. *J Bras Pneumol*. 2025;51(1):e20240412. DOI: <https://doi.org/10.36416/1806-3756/e20240412>
6. Shamim H, Singh AK, Sharma R, Mishra RK. COPD 2.0: bronchodilators, biologics and beyond - a systematic review. *Lung India*. 2026;43(1):62-66. https://doi.org/10.4103/lungindia.lungindia_199_25
7. Janssens W, Verleden GM. Nonpharmacological interventions in COPD. *Eur Respir Rev*. 2023;32(167):230028. <https://doi.org/10.1183/16000617.0028-2023>
8. Hanania NA, Braman S, Adams SG, Adewuya R, Ari A, Brooks J, et al. The role of inhalation delivery devices in COPD: perspectives of patients and health care providers. *Chronic Obstr Pulm Dis*. 2018;5(2):111-123. <https://doi.org/10.15326/jcopdf.5.2.2017.0168>
9. Marko M, Pawliczak R. Inhalation technique-related errors after education: a systematic review and meta-analysis. *NPJ Prim Care Respir Med*. 2025;35:15. <https://doi.org/10.1038/s41533-025-00422-0>
10. Mohd Arif N, Lee PY, Cheong AT, Ananthan RNA. Factors associated with improper metered-dose inhaler technique among adults with asthma in a primary care clinic in Malaysia. *Malays Fam Physician*. 2021;16(2):58-66. <https://doi.org/10.51866/oa1231>
11. Cho-Reyes S, Celli BR, Dembek C, Yeh K, Navaie M. Inhalation technique errors with metered-dose inhalers among patients with obstructive lung diseases: a systematic review and meta-analysis of U.S. studies. *Chronic Obstr Pulm Dis*. 2019;6(3):267-280. <https://doi.org/10.15326/jcopdf.6.3.2018.0168>
12. Sanaullah T, Khan S, Masoom A, Mandokhail ZK, Sadiqa A, Malik MI. Inhaler use technique in chronic obstructive pulmonary disease patients: errors, practices and barriers. *Cureus*. 2020;12(9):e10569.
13. Marko M, Pawliczak R. Inhalation technique-related errors after education. *NPJ Prim Care Respir Med*. 2025;35:15. <https://doi.org/10.1038/s41533-025-00422-0>
14. Rahman N, Ullah U. Comparison of inhaler technique between DPI and MDI. *Pak J Chest Med*. 2025;31(4):291-298.
15. Castel-Branco MM, Fontes A, Figueiredo IV. Identification of inhaler technique errors with a routine procedure in Portuguese community pharmacy. *Pharmacy Practice*. 2017;15(4):1072. DOI: <https://doi.org/10.18549/PharmPract.2017.04.1072>
16. Zhou LJ, Wen XX, Jiang R. Inhaler use in COPD patients: meta-analysis. *Front Nurs*. 2022;9(4):343-352. <https://doi.org/10.2478/fon-2022-0044>
17. Usmani OS, Lavorini F, Marshall J, Dunlop WC, Heron L, Farrington E, Dekhuijzen PNR. Effectiveness of one-on-one coaching in improving pressurized metered dose inhaler technique in patients with chronic obstructive pulmonary disease. *BMC Pulmonary Medicine*. 2021;21:264. <https://doi.org/10.1186/s12890-021-01627-y>
18. Ocakli B, Ozmen I, Tuncay EA. Comparative analysis of inhaler errors. *Int J COPD*. 2018;13:2941-2947. <https://doi.org/10.2147/COPD.S178951>