Original Article

Accuracy of Inhaler Use in COPD Patients and Factors Affecting It

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Abstract

Background: An inhaler is a type of dosage form used in the treatment of chronic obstructive pulmonary disease (COPD). The inhaler has a unique technique for use; however, the percentage of accuracy in inhaler use is still low. Proper inhaler use is expected to improve quality of life and decrease the occurrence of exacerbations. This study aimed to observe the percentage of accuracy in using inhalers and the factors that influence it.

Method: This study was conducted with a cross-sectional design on COPD patients in two different hospitals. Primary data were collected using a questionnaire. The accuracy of inhaler use was assessed using a checklist.

Results: The total number of patients in this study was 110, with an average age of 62 years. Patients were given single inhaler therapy, which included Dry Powder Inhalers (DPI) for 34 patients with 70.7% accuracy, Pressurized Metered-Dose Inhalers (pMDI) for 9 persons with 45.74% accuracy, and Soft Mist Inhalers (SMI) for one person with 66.67% accuracy. Furthermore, patients who used a combination of pMDI and DPI inhalers had an accuracy value of 68.53%, while a combination of pMDI and SMI had an accuracy value of 72.72%. The stage with the lowest level of accuracy in the pMDI-type inhaler used alone was exhaling before the inhaler was supplied.

Conclusion: According to the findings, the accuracy of inhaler use in COPD patients is still relatively low. Furthermore, gender is a factor that has a statistically significant relationship with inhaler accuracy.

Keywords: COPD, DPI, inhaler technique, pMDI, SMI

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is one of the three leading causes of death in the world. It is a common respiratory disorder characterized by persistent symptoms and airflow limitation due to exposure to harmful particles or gases. Treatment of stable or exacerbated COPD is carried out using an inhaler. Inhalers require specific techniques for use and are one of the causes of medication noncompliance.[1] Although inhalers are one of the best drug delivery devices, and previous study obtained that only 3% of patients found inhaler use difficult, half of these patients demonstrated incorrect inhaler use.[2]

In Indonesia, there are several types of inhalers in circulation with different drug formulations, such as Pressurized Metered-Dose Inhalers (pMDI), Dry Powder Inhalers (DPI), and Soft Mist Inhalers (SMI). All three types of inhalers are widely used by patients with COPD.[3] Unfortunately, only 2.86% of patients use the inhaler appropriately for all its stages.[4]

The Test of Adherence to Inhaler Toolkit has divided the causes of non-compliance by patients using inhalers into 3 categories, which include sporadic (reminders and counseling), deliberate (education and counseling), and unconscious (treatment plan and inhaler use instructions).[5] Inappropriate use of inhalers can lower disease control, increase drug consumption and side effects, increase the frequency of acute attacks or exacerbations, hospitalizations, drug expenses, and impair treatment success.[6]

According to one study, providing information on the inhaler use method reduced the frequency of moderate-to-severe yearly exacerbations and hospitalizations.[7] In this study, the accuracy of each stage of inhaler use in COPD patients was evaluated. We then assessed if any baseline patient characteristic influenced inhaler accuracy.

METHODS

A cross-sectional study was performed to examine the characteristics of COPD patients and assess the level of accuracy of inhaler use. The Universitas Indonesia Hospital Ethics Committee accepted this study under approval number S-049/KETLIT/RSUI/X/2022 with protocol number 2022-07-175. Consecutive sampling was conducted on COPD patients who underwent treatment control at Menteng Mitra Afia Hospital in November 2022, and at Grha Permata Ibu Hospital in December 2022. Sampling was terminated at the end of the sampling period.[8]

The inclusion criteria were patients diagnosed with COPD by a doctor, receiving at least one therapy administered in the form of an inhaler, and being willing to participate in the study as indicated by signing an informed consent. Patients with other chronic lung disorders, such as tuberculosis (TB) and pulmonary fungal infections, as well as those who were blind, deaf, speech-challenged, or illiterate, were excluded from this study. Demographic data from each patient was documented using a questionnaire regarding the patient's basic characteristics. The treatment data used was the treatment at the time the study was taken.

A different list was used for each type of inhaler circulated in Indonesia. Proper use of each step was scored separately. The checklist is from the NPS Medicine Wise Inhaler Technique: A device-specific checklist that has been adapted and used in the study of Sauriasari et al.[9] The list of steps to be performed is listed in Table 1. The accuracy score of inhaler use is defined as the percentage of correct steps compared to the total number of steps that should be executed. Patients who use combination inhalers demonstrated each inhaler separately.

Descriptive statistics were assessed with frequencies and percentages for qualitative variables and averages for quantitative variables. To see the correlation between two variables, the ANOVA test and the Pearson test were used. All analyses were performed using SPSS version 23. The value of $P<0.05$ was considered significant.

Table 1. Stages of inhaler use

Inhaler Type	Stages of Use
Diskus	1. Open the cap of the inhalation medication using your thumb.
	2. Hold the inhalation medication horizontally and set the dose by sliding the lever until it clicks.
	3. Exhale slowly and as fully as possible, away from the inhalation medication.
	4. Place the mouthpiece of the inhalation medication between the teeth without biting, and close the lips. Do not block the air outlet.
	5. Breathe in continuously and deeply.
	6. Hold your breath for 5 seconds or as long as possible (maximum 10 seconds).
	7. When holding your breath, remove the inhalation medication from your mouth.
	8. Exhale slowly, away from the inhalation medication.
	9. Close the inhalation medication after use.
	10. If the inhalation medication contains steroids, rinse your mouth with clean water after using the inhalation medication and do not swallow the remaining water.
Turbuhaler	1. Twist and remove the inhalation cap.
	2. Keep the inhalation medication in an upright position while turning the grip (red color) to the right.
	3. Turn the grip back the other way (toward the left) until it clicks.
	4. Exhale slowly, away from the inhalation medication.
	5. Place the inhalation mouthpiece between the teeth without biting, and close the lips. Do not block the air outlet.
	6. Breathe in strongly and deeply.
	7. Hold your breath for 5 seconds or as long as possible (maximum 10 seconds).
	8. When holding your breath, remove the inhalation medication from your mouth.
	9. Exhale slowly, keeping away from the inhalation medication.
	10. Close the inhalation medication after use.
	11. If the inhalation medication contains steroids, rinse your mouth with clean water after using the inhalation medication, and do not swallow the rinse.

Table 1. Stages of inhaler use (continue)

Inhaler Type	Stages of Use
PMDI	1. Unscrew the cap of the inhalation medication.
	2. Hold the inhalation medication in an upright position and shake it well.
	3. Exhale slowly, away from the inhalation medication.
	4. Place the inhalation medication between the teeth without biting, and keep the lips together
	5. Inhale slowly from the mouth, and at the same time, press the canister firmly.
	6. Continue to breathe in slowly and deeply.
	7. Then hold your breath for 5 seconds or as long as possible (maximum 10 seconds).
	8. While holding your breath, remove the inhalation medication from your mouth.
	9. Exhale slowly, away from the inhalation medication.
	10. Close the inhalation medication after use.
	11. If the inhalation medication contains steroids, you should rinse your mouth with clean water after using the inhalation medication, and do not swallow the remaining rinse water.
Breezhaler	1. Open the cap of the inhalation medication.
	2. Open the mouthpiece of the inhalation medication.
	3. Remove the capsule from the blister and place it in the capsule holder.
	4. Close the mouthpiece of the inhalation medication until it clicks.
	5. Press the right and left side buttons of the inhalation medication simultaneously and release (do not shake).
	6. Exhale one breath at a time.
	7. Place the mouthpiece of the inhalation medication between the teeth without biting, and keep the lips together.
	8. Breathe in strongly and deeply.
	9. Hold your breath for 5 seconds or as long as possible (maximum 10 seconds).
	10. While holding your breath, remove the inhalation medication from your mouth.
	11. Exhale slowly, away from the inhalation medication.
	12. Open the mouthpiece of the inhalation medication and take out the capsule. Check if it is empty.
	13. Close the inhalation medication after use.
	14. If the inhalation medication contains steroids, rinse your mouth with clean water after using the inhalation medication, and do not swallow the remaining rinse water.
Respimat	1. Hold the inhalation medication upright with the cap closed.
	2. Slide the bottom of the inhalation medication to the right (in the direction of the arrow) until it clicks (half a turn).
	3. Open the cap of the inhalation medication completely.
	4. Exhale slowly, away from the inhalation medication.
	5. Place the inhalation mouthpiece between the teeth without biting, and keep the lips together. Do not block the air outlet.
	6. Inhale slowly and deeply through the mouth, and at the same time, press the dose button.
	7. Continue to breathe in slowly and deeply.
	8. Hold the breath for 5 seconds or as long as possible (maximum 10 seconds).
	9. While holding your breath, remove the inhalation medication from your mouth.
	10. Exhale slowly, away from the inhalation medication.
	11. Close the inhalation medication after use.
	12. If the inhalation medication contains steroids, rinse your mouth with clean water after using the inhalation medication, and do not swallow the remaining rinse water.

RESULTS

This study included 110 patients with a mean age of 62 years, consisting of 32 female and 78 male patients. Only 20% (n=22) had a diploma or a university degree. The majority, 40% (n=44), had completed high school. About 76% (n=84) had a smoking history and had quit, but 11.82% (n=13) claimed to continue smoking. Table 2 shows detailed patient features.

As many as 35 patients were given only one type of inhaler, with four receiving only the reliever in the form of pMDI and 31 receiving both DPI and SMI controls. Twelve patients utilized a turbuhaler, sixteen used a diskus, two used a breezhaler, and one used a Respimat. A total of 75 individuals received more than one inhaler, with 72 receiving a combination of pMDI and DPI, and three receiving a combination of pMDI and SMI. Table 2 contains more complete information.

Table 2. Distribution of disease status and treatment-related factors in patients using different devices

Characteristic	Inhaler					*P*
	DPI	pMDI	pMDI + DPI	pMDI + SMI	SMI	
Gender						
Male	18 (23.08%)	7 (8.97%)	50 (64.10%)	2 (2.56%)	1 (1.28%)	0.086[a]
Female	16 (50.00%)	2 (6.25%)	13 (40.63%)	1 (3.13%)	0 (0.00%)	
Age (mean)	60.17	63.67	62.7	70.67	77	0.162[b]
Age range						
19–44	1 (25.00%)	0 (0.00%)	3 (75.00%)	0 (0.00%)	0 (0.00%)	
45–59	9 (39.13%)	0 (0.00%)	14 (60.87%)	0 (0.00%)	0 (0.00%)	0.735[a]
>60	24 (28.92%)	9 (10.84%)	46 (55.42%)	3 (3.61%)	1 (1.20%)	
Education						
Elementary school	9 (36.00%)	1 (4.00%)	14 (56.00%)	1 (4.00%)	0 (0.00%)	
Middle school	5 (26.32%)	2 (10.53%)	11 (57.89%)	1 (5.26%)	0 (0.00%)	0.570[a]
High school	13 (29.55%)	6 (13.64%)	25 (56.82%)	0 (0.00%)	0 (0.00%)	
College/university	7 (31.82%)	0 (0.00%)	13 (59.09%)	1 (4.55%)	1 (4.55%)	
Working						
Employe	11 (34.38%)	1 (3.13%)	18 (56.25%)	2 (6.25%)	0 (0.00%)	0.398[a]
Unemployed	23 (29.49%)	8 (10.26%)	45 (57.69%)	1 (1.28%)	1 (1.28%)	
Smoking status						
Non-smoker	5 (38.46%)	0 (0.00%)	8 (61.54%)	0 (0.00%)	0 (0.00%)	
Passive smoker	5 (71.43%)	1 (14.29%)	1 (14.28%)	0 (0.00%)	0 (0.00%)	0.265[a]
Ex-smoker	23 (27.38%)	6 (7.14%)	51 (60.71%)	3 (3.57%)	1 (1.19%)	
Current smoker	1 (16.67%)	2 (33.33%)	3 (50.00%)	0 (0.00%)	0 (0.00%)	
Comorbid						
With comorbid	21 (32.81%)	6 (9.38%)	34 (53.13%)	2 (3.13%)	1 (1.56%)	0.788[a]
Without comorbid	13 (28.26%)	3 (6.52%)	29 (63.04%)	1 (2.17%)	0 (0.00%)	
Therapy						
Reliever	2 (50.00%)	2 (50.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Controller	32 (91.43%)	2 (5.71%)	0 (0.00%)	0 (0.00%)	1 (2.86%)	<0.001[a]
Reliever and controller	0 (0.00%)	5 (7.04%)	63 (88.73%)	3 (4.23%)	0 (0.00%)	
No. of inhaler						
1	31 (88.57%)	3 (8.57%)	0 (0.00%)	0 (0.00%)	1 (2.86%)	
2	3 (4.35%)	6 (8.69%)	57 (82.61%)	3 (4.35%)	0 (0.00%)	<0.001[a]
3	0 (0.00%)	0 (0.00%)	6 (100.00%)	0 (0.00%)	0 (0.00%)	
Education history						
Literate	21 (26.92%)	5 (6.41%)	48 (61.54%)	3 (3.85%)	1 (1.28%)	0.298[a]
Illiterate	13 (40.63%)	4 (12.50%)	15 (46.88%)	0 (0.00%)	0 (0.00%)	

Note: [a]Pearson chi-square test; [B]ANOVA test

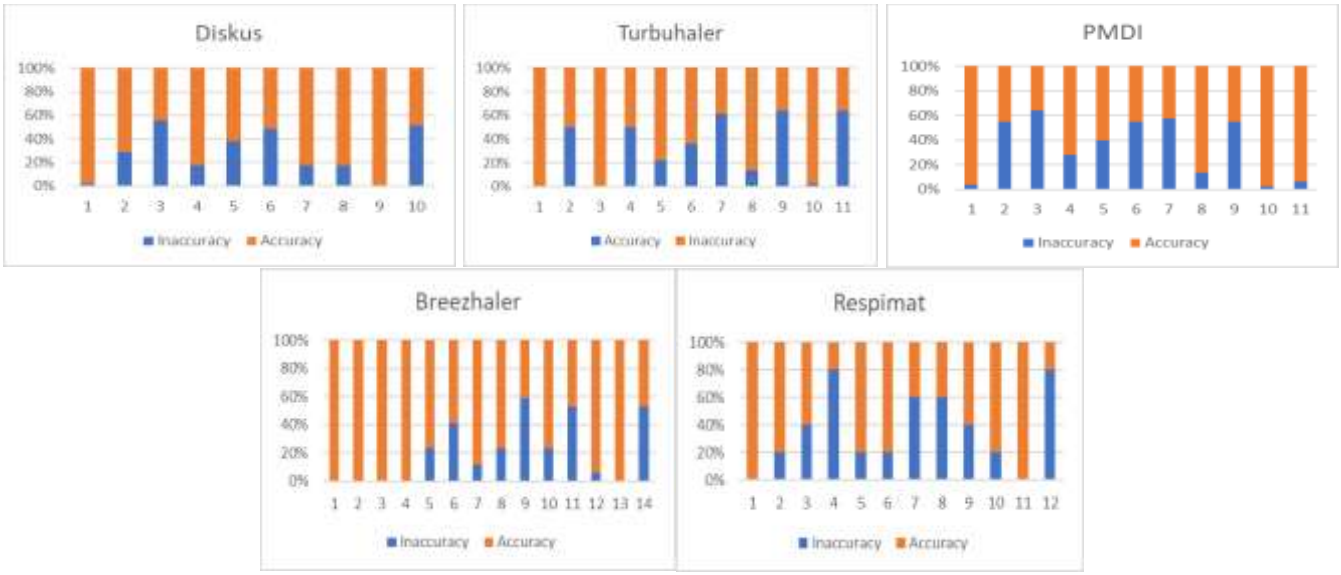

Figure 1. Percentage of inaccuracies committed by patients for each inhaler use

Table 3. Relationship between each variable and the percentage accuracy of inhaler use

Variable	Average of Accuracy	*P*
Gender		
Male (n=78)	64.87%	0.046[a]
Female (n=32)	73.38%	
BMI		
<18.5 (n=24)	62.50%	
18.6-24.9 (n=46)	64.33%	0.063[b]
25-29.9 (n=27)	74.85%	
>30 (n=13)	71.38%	
Age		
19-44 (n=4)	67.00%	
45-59 (n=23)	71.04%	0.572[b]
>60 (n=83)	66.34%	
Smoking		
Current smoker (n=6)	63.83%	
Ex-smoker (n=84)	65.94%	0.160[b]
Passive smoker (n=7)	83.57%	
Non-smoker (n=13)	69.31%	
Education		
Elementary school (n=25)	62.88%	
Middle school (n=19)	70.58%	0.063[b]
High school (n=44)	64.05%	
College/University (n=22)	76.23%	
Therapy		
Reliever (n=4)	50.00%	
Controller (n=35)	70.40%	0.135[b]
Reliever and controller (n=71)	66.82%	
No. of inhaler		
1 (n=35)	69.77%	
2 (n=69)	65.30%	0.295 [b]
3 (n=6)	76.67%	
Education History		
Literate	69.11%	0.147[a]
Illiterate	63.36%	

Note: BMI=Body Mass Index; [a]Mann-Whitney test, [b]Kruskal-Walis test

Five patients utilized the inhaler correctly at all stages. The highest percentage of inhaler accuracy was 79% in patients using Breezhaler-type inhalers, followed by 69.15% in patients using Diskus-type inhalers. Figure 1 depicts specific problems in inhaler use techniques.

Table 4. Percentage of accuracy of inhaler use for each inhaler combination

Inhaler	Accuracy
DPI (n=34)	70.70%
pMDI (n=9)	45.74%
pMDI + DPI (n=63)	68.35%
pMDI + SMI (n=3)	72.72%
SMI (n=1)	66.67%
Total (n=110)	68.54%

Note: pMDI=Pressurized metered-dose inhalers; DPI=Dry Powder Inhalers; SMI=Soft Mist Inhalers

DISCUSSION

This study evaluated the accuracy of inhaler use and the factors that influence it and found that the accuracy of inhaler use was 68.54%. Gender was a factor that showed a statistically significant relationship with the level of accuracy in using inhalers. This is important because identifying and characterizing incorrect inhaler use is the first step to determining the next intervention to improve inhaler use techniques.[10]

The accuracy of inhaler use in this study is close to previous studies, which stated that the error rate of inhaler use reached 25.3%.[11] Based on the combination of inhalers used by each patient, a more detailed level of accuracy can be shown. Table 4 shows the accuracy value for each combination of inhalers used, with the lowest accuracy value occurring in patients who use a single pMDI-type inhaler, with an accuracy level of only 45.74%. This is consistent with a prior study, which obtained that the level of inaccuracy in the usage of pMDI-type inhalers was 38.9% and pMDI combined with a spacer was 42.3 %.[4]

Similar to diskus and Respimat-type inhalers, the lowest percentage appears in the stage of slowly exhaling before administering the inhaler, which was 36 % in the pMDI type, 44% in the Diskus-type inhaler, and 20% in the Respimat-type inhaler. The stage of holding one's breath after spraying the inhaler had the second lowest accuracy rate in pMDI, Turbuhaler, and Respimat-type inhalers, with 42.67%, 39%, and 40%, respectively. Both stages are crucial in the use of pMDI, which has a consistently low percentage of accuracy.[12,13]

According to another study, the most common errors were not exhaling before using the inhaler, breathing through the nose, and not retaining the breath.[11] Breathing is typically more difficult to coordinate than other processes such as opening the cap or rotating the inhaler, especially in individuals with coughs or dyspnea.[14] Furthermore, if the inhalation medication contained steroids, the gargling step in Diskus, Turbuhaler, Breezhaler, and Respimat-type inhalers was frequently overlooked.

Patients did not rinse their mouth after using steroid-containing inhalers because they were unaware of the benefits and significance of this step, which was consistent with previous research.[15] Each type of inhaler has stages that are risk factors for errors in their use.[16] Details of the accuracy for each stage of inhaler use can be seen in Figure 1.

In addition to analyzing inhaler accuracy, this study looked at the presence or absence of basic patient characteristics that influence inhaler accuracy. Table 3 shows that age, smoking history, education history, type of therapy, and quantity of inhalers used do not have a statistically significant link with inhaler accuracy. Furthermore, there was a statistically significant relationship between gender and inhaler accuracy. Inconsistent findings have been found in studies on the relationship between gender and inhaler accuracy.[17]

Similar to other studies, this one showed that the accuracy of inhaler use in men was lower than in women.[12] However, some studies state otherwise, and other studies say there is no significant relationship between gender and the accuracy of inhaler use.[4,14,18] In addition, this study showed that BMI had no significant relationship with inhaler accuracy. However, other studies have suggested that BMI is closely related to COPD risk factors.[19]

The GOLD 2022 stated that smoking habits, adherence levels, and inhaler use techniques are influential in COPD management.[20] Six patients in this study still smoked. Although there was no statistically significant relationship between smoking habits and inhaler accuracy, the group that still smoked had the lowest inhaler accuracy of the other groups, at 63.83%. Furthermore, smoking is linked to risk factors and clinical conditions because it raises oxidative stress levels in the body, which are highly reactive to inflammatory cells.[21,22] Therefore, smoking can cause exacerbations in COPD patients.[22]

This study did not show a statistically significant relationship between the accuracy of inhaler use and education level. However, in another study, it was mentioned that patients with higher basic education would have a better understanding of the disease and the therapy.[23] It was found that the level of education affects the patient's level of understanding at each stage of inhaler use. In addition, patients with lower levels of education tended to make mistakes at critical points in the use of inhalers.[13]

The correct use of inhalers is an important point in COPD therapy because it will affect the number of doses administered and the effectiveness of treatment. Health workers need to understand the types of inhalers that can be used well by individual patients and emphasize important steps in their use.[15] Repeated demonstrations of inhaler use through various supporting media will be highly effective in reducing incorrect inhaler use, which will manifest in treatment effectiveness.[14,24] The absence of a significant relationship between the history of education and the accuracy of using inhalers indicates that there is a need for repeated education of COPD patients regarding their treatment.[4]

LIMITATION

There are several limitations to this study. First, there was no information on how long the patient used the inhaler, so the correlation with inhaler accuracy could not be determined. Second, we did not gather data on the incidence of exacerbations, so we cannot determine whether inhaler misuse affects the incidence of exacerbations. And third, we did not do proportional sampling, so the number of samples in each group was different. If further research is carried out based on the inhalers used, proportional sampling can be carried out so that each inhaler group has the same number of samples.

CONCLUSION

The study found that inhaler accuracy in COPD patients was still relatively low, with a total accuracy of only 68.54%. Furthermore, this study found that gender and BMI are factors that have a statistically significant relationship with inhaler accuracy. However, more research is required. Understanding

the sort of inhaler that can be used appropriately for each patient, offering instruction on inhaler use procedures, and validating the patient's abilities are all key aspects of treatment.

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CONFLICT OF INTEREST

This research has no conflict of interest.

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