Journal of
Cardio - Thoracic Medicine

http://jctm.mums.ac.ir

Evaluation of inhaler use technique among patients with chronic obstructive pulmonary disease

Asieh Hatefi[1], Ali Emadzadeh [2], Mahnaz Amini [3], Nasrin Milani [*1]

[1]Pulmonologist, Department of Internal Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
[2]Department of Medical Education, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
[3] Pulmonologist, Lung Diseases Research Center, Division of Sleep Medicine, Psychiatry and Behavioral Sciences Research Center, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

ARTICLEINFO

Article type:
Original Articles

Article history:
Received: 20 April 2021
Revised: 28 May 2021
Accepted: 08 June 2021

Keywords:
Chronic Obstructive Pulmonary Disease
Inhalation Devices
Technique

ABSTRACT

Introduction: Chronic obstructive pulmonary disease (COPD) is a common medical problem. The improper implementation of inhaler techniques thatare used in such patients leads to the reduced effect of medicines. This study was conducted to evaluate the correct use of various inhalers among COPD patients.

Materials and Methods:This observational, cross-sectional study was carried out on 96 patients with COPD aged over 40 years. The samples were selected using asystematic random samplingmethod from patients with COPD referring to the clinics of Ghaem and Imam Reza hospitals, Mashhad, Iran, from March 2018 to March 2019. The subjects were informed that their participation in the study was voluntary. These cases were under the treatment of using at least one inhaled medicine for a month or more. The adopted technique of applying four types of inhalers was evaluated by a standard checklist. The patients' performance scores of all procedures were recorded, and the collected data were analyzed in SPSS software (version 16).

Results: Our study revealed that more than 98% of patients used metered-dose inhaler (MDI) spray (P=0.05). The patients' scores on the correct use of MDI, Diskus, Turbuhaler, and HandiHaler inhalers were estimated at 68, 77, 87, and 90%, respectively. The most common mistakes in using MDI and HandiHaler inhalers were related to the 'holding the breath' and "taking a deep inhale' steps after using the inhaler, respectively.

Conclusion: Physicians must evaluate and modify the use of inhalers in every COPD patient. It is recommended that easy-to-use inhalers, such as HandiHaler, be prescribed for such patients.

► *Hatefi, A., Emadzadeh, A., amini, M., Milani, N. Evaluation of inhaler use technique among patients with chronic obstructive pulmonary disease.J Cardiothorac Med. 2021; 9(2): 786-797*

Introduction

Chronic obstructive pulmonary disease (COPD) is a common disease worldwide with the estimation of affecting approximately 7% of the world's population (1). Currently, according to the World Health Organization, COPD is not only highly prevalent but also is the fourth leading cause of death. It is predicted that it will be the third leading cause of death worldwide by 2030 (2, 3).

*Corresponding author: Nasrin Milani, Department of Internal Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.Tel: +985138012850, E-mail: nasrinmilani@gmail.com

Therefore, this disease is an important health challenge, and although it can be prevented and treated, it imposes an extreme burden on healthcare systems (4). No definitive treatment has been developed for COPD and the available medical therapies can merely improve symptoms and reduce the frequency and severity of attacks (5, 6).

A wide range of different forms of inhalers is available for patients in the form of metered-dose inhalers (MDI) and nebulizers, breath-actuated MDIs, and five types of dry powder inhalers (DPI), including Turbuhaler, Diskus, and HandiHaler, among which MDIs are widely prescribed. However, the results of various studies showed a large number of respiratory patients (4-96%), including COPD and asthma, use a variety of inhalers with wrong techniques (7-9). In a meta-analysis reviewing about 38 studies, it was not ultimately determined exactly which respiratory device had the highest error of use (10).

Various articles have divided the errors of inhalers use into two categories of critical and non-critical errors and have identified these errors based on a series of checklists. Based on this categorization, critical errors lead to suboptimal control of disease (11). Since incorrect inhaler use is associated with aggravating and not controlling the symptoms in COPD patients, increasing the use of various drugs, and reducing the effect of drugs, it can increase morbidity and mortality among such patients (11, 12). Nevertheless, satisfactory clinical results would be obtained if patients use inhalers with the correct technique and follow the manufacturer's instructions (7, 13). A meta-analysis reported total and critical error ranges of 50-100% and 14-92% regarding all devices, respectively. It is noteworthy to indicate that the heterogeneity rate among all studies is generally higher than 90%, showing a high variability of them (14).

Therefore, this study was performed to determine the correct use of various inhalers among outpatients with obstructive pulmonary disease to identify the most important technical problems experienced by patients as well as the inhalers with the least error rate. Moreover, this research aimed to determine whether other factors, such as patient characteristics and previous training, can affect the use of such medications. As a result, it would be possible to better identify the groups in need of training

Materials and Methods

Demographic information of patients

This observational cross-sectional study was conducted at pulmonary subspecialty clinics of Ghaem and Imam Reza General tertiary-care teaching hospitals, Mashhad University of Medical Sciences, Mashhad, Iran. The population of this research consisted of 96 patients with COPD selected by systematic random sampling methodamong the patients referring to the pulmonary subspecialty clinics for treatment within March 2018 to March 2019. The eligible subjects were entered into the study voluntarily after informed consent was obtained from them. The present study was approved by the Ethics Committee of Mashhad University of Medical Sciences (IR.MUMS.fm.REC.1395.241).

Inclusion and exclusion criteria

The inclusion criteria were patients aged over 40 years, diagnosed with COPD confirmed by Chronic Obstructive Lung Disease and spirometry, and who received treatment with one or more inhalation medicines for at least 1 month.These patients were trained by general practitioners, specialists, or fellowships and nurses trained in this field according to the protocol specified by pharmaceutical companies.

However, the patients with severe tremor, Alzheimer's, dementia and severe forgetfulness, confusion or decreased level of consciousness, psychosis and acute psychiatric problems, severe visual and hearing impairments affecting the proper use of the inhaler were excludedfrom the study.

In this research, the application techniques of four types of MDI spray from pharmaceutical companies in Iran, including Diskus Turbuhaler, HandiHaler Turbuhaler, Diskus, and HandiHaler, were evaluated according to a standard checklist including 12-18 steps (Table 1).

The critical steps werealso specified for each device. This standard checklist was prepared based on the studies conducted in this domain (15-18). The validity and reliability of this questionnaire have been investigated in previous studies (15, 16). The reliability of this instrument was estimated and confirmed using the Cronbach alpha coefficient method in a previous study (α=0.8) (15).The amount of previous training and level of education, knowledge, and cognition were different among subjects. These factors were determined as confounding variables.

Table 1. Checklist of the correct use of four respiratory devices

Steps of applying MDI spray
1. Removes the inhaler cap *
2. Shakes the inhaler gently *
3. Holds the inhaler mouthpiece upright
4. Uses spacer
5. Fixes the inhaler in the right place of the spacer
6. Take a deep, gentle exhale
7. Closes the lips around the spacer (or inhaler) mouthpiece *
8. Holds the inhaler mouthpiece between teeth
9. Does not enter the tongue in the spacer
10. Press the inhaler once *
11. Takes a gentle, deep inhale up to TLC *
12. Holds the breath
13. Holds the breath for ten counts
14. Inhales and exhales slowly several times
15. Waits some seconds before taking the next puff
16. Rinses mouth after Corton inhaler
17. Observes the order of the above instructions
18. Washes the spacer
Steps of using DPI Turbuhaler inhaler
1. Does not shake the inhaler
2. Opens the cap
3. Holds inhaler mouthpiece upright *
4. Turns the inhaler once to the left and the end and then return *
5. Takes a deep, gentle exhale
6. Does not use a spacer
7. Holds the inhaler between the teeth
8. Closes the lips around the mouthpiece of the inhaler
9. Does not enter the tongue in the inhaler
10. Takes a deep, quick inhale up to TLC *
11. Holds breath up for ten counts
12. Does not rotate the inhaler after use
13. Puts the cap
14. Observes the order of the above instructions
Steps of using Diskus DPI inhaler
1. Holds the inhaler with one hand and correctly *

To continue….

2. Pushes the grip away until it clicks into place *
3. Places the mouthpiece between the lips
4. Does not enter the tongue in the mouthpiece
5. Does not shake the inhaler
6. Does not use a spacer
7. Take a deep, gentle exhale away from the inhaler
8. Breathes in deeply and quickly up to TLC *
9. Slides the thump grip backward until it clicks
10. Waits a few seconds before taking the next puff
11. Rinses mouth after using Corton inhaler
12. Does not wash the inhaler
Steps of using DPI HandiHaler/Revilizer inhaler
1. Takes the capsule out of the can/ Peels back foil to remove the capsule
2. Opens mouthpiece completely *
3. Places the capsule in chamber*
4. Closes mouthpiece until it clicks
5. Press the inhaler needle *
6. Breaths out gently (away from the inhaler)
7. Places mouthpiece between lips *
8. Does not enter the tongue in the inhaler
9. Breathes in deeply and quickly up to TLC
10. Holds breath
11. Holds breath for ten counts *
12. Removes the capsule out of the chamber
13. Detects empty inhaler
14. Do not wash the inhaler

TLC: Total lung capacity; MDI: Metered-dose inhaler; DPI: Dry powder inhaler* Basic steps of applying a Turbuhaler.

The researchers, initially, collected the demographic characteristics of the participants, including age and gender, medical records, comorbidities, number of hospitalizations and referrals within the past year, and the type, duration, and frequency of medication.

All patients were trained to use the inhaler by the healthcareprofessionals in this era, including nurses, specialists, fellowships, and general practitioners in previousvisits at least once before the recruitment in the study in the tertiary teaching hospital. All of these trainers almost had the same method according to the same structure. Subsequently, a trained non-physician individual requested patients to demonstrate how they use their inhaler. This individual was trained on how to use the inhaler properly as well as detecting patients' errors. The patients using more than one type of inhaler were examined regarding all respiratory devices. According to the checklist, a score of one was considered in case that the patient performed each step of the inhaler spray correctly; nevertheless, if it was performed incorrectly, a score of zero was recorded in the relevant steps. The total scores of patients were calculated as the percentage of correct use. The mean scores of the correct used technique for each inhaler, including MDI, Turbuhaler, Diskus, and HandiHaler, were obtained for COPD patients. Moreover, each device was evaluated and errors at each stage of using the inhaler were recorded; however, they

were not prescribed new medicines or a placebo for the purpose of the study.

The general score of patients in the adopted technique of using the inhaler was recorded, and in case that the subjects showed errors in one of the basic stages of this process, they were divided into two groups of "correct" and "incorrect" users.; No feedback was given during the procedure.

Statistical analysis

The collected data from the demographic characteristics of patients and the results of the checklist of how to use inhaled medicines were recorded and analyzed in SPSS software (version 16). At first, descriptive statistics (i.e., measure of dispersion and central tendency) were calculated, followed by using the Kolmogorov-Smirnov test to evaluate the data distribution. In this respect, parametric and non-parametric tests were used for normal and non-normal data distribution, respectively. The acceptable error rate in this study was considered less than 0.05. The logistic regression model was also used to control the intervening variables to determine the relationship between the independent variable and the categorized values of the dependent variables

. Results

A total of 96 patients from 150 eligible patients were entered into our study. In our study, the mean age of patients was obtained as 64±12.6. The patients' demographic and clinical care characteristics and are summarized in tables 2 and 3.

Table 2. Demographic characteristics of patients

Parameter (Classification)		Number (%) or Mean±SD
Gender	Male	42 (43.8%)
	Female	54 (56.2%)
Smoking	No	45 (46.9%)
	Yes	1 (12.5%)
	Used to	39 (40.6%)
Addiction	No	62 (64.6%)
	Yes	24 (25%)
	Withdrawal	10 (10.4%)
Occupation	Employed	29 (30.2%)
	Unemployed	67 (69.8%)
Living place	Urban	69 (71.9%)
	Rural	27 (28.1%)
Literacy	Illiterate	55 (57.3%)
	Literate	41 (42.7%)
Education level	Under diploma	39 (40.6%)
	Academic	2 (2%)
Other diseases	Diabetes	30 (31%)
	High blood pressure	59 (61%)
	Heart diseases	30 (31%)
Mean age (years)	All patients	64.3±12.6
	Females	64±13.5
	Males	64.5±11.4
Cigarette packs per year		37.8±15

Cigarette packs per year: Number of cigarette packs × number of years of smoking, SD: Standard deviation

Table 3. Characteristics of patient's clinical care

	Mean	SD	Minimum	Maximum
Number of training of correct inhaler use technique	3	1.8	1	10
Patients' visits within the last year	6	5	1	30
Duration of diagnosis (months)	73	84	1	480
Duration of using the inhaler (months)	57	66	1	300
Number of hospitalizations during the last year	1.4	1.7	0	10

SD: Standard deviation

All patients had been trained to use the inhaler at least once before referring to the clinic. In our study, half of the patients (n=48) used one form and the other half (n=48) used more than one form of an inhaler. Based on the result, 98.96%, 16.7%, 4.2%, and 36.5% of patients used MDI spray, Turbuhaler, Diskus, and HandiHaler, respectively. The most commonly used inhaler was reported to be MDI, and 72% of patients used MDI spray with a spacer. The main reasons for not using spacer were its bulkiness and difficulty of transportation. According to the findings, 19.8% of patients had a history of stopping using inhalers without a doctor's recommendation with the reasons of observing improvement of symptoms (63.2%), having forgotten (26.3%), and having fear of developing a dependence on inhalers (10.5%). The mean scores of the correct technique for using each inhaler in COPD patients were obtained as 68%, 87%, 77%, and 90.2% for patients using MDI, Turbuhaler, Diskus, and HandiHaler, respectively.

Steps of inhaler proper use

Regarding the steps of using MDI spray (Figure 1.A), only the step of "removing the cap" was performed correctly by 100% of the patients and the other steps were conducted with some degree of error. Regarding this, the most technical errors in using MDI spray were related to 'washing the spacer' (step 18), 'holding the breath after using the inhaler'(step 13) (12). It was also revealed that the most technical errors in using Turbuhaler inhaler were reported to be respectively 'taking a deep and quick inhale after using inhaler' (steps 10), which was a critical error, and 'holding the breath after using inhaler' (step 11), which was a non-critical error (figure 1B). The first step of all inhalers, 'removing the cap', was performed error-free. However, the first step of using the Diskus inhaler, 'holding the inhaler correctly', was conducted with 75% error.

According to the findings, the steps of 'pushing the grip away until it clicks into place' (step 2) and 'taking a deep quick inhale after using inhaler' (step 8) were found to be the most technical errors in using Diskus inhaler (figure1C). It was revealed that the HandiHaler inhaler was used with the least errors, in which 9 of 14 steps were performed without any technical error. The most technical errors reported in using HandiHaler inhaler were related to stages 'breathing in deeply and quickly up to TLC' (step 9), which was a non-critical error, and 'holding the breath after using inhaler' (step 11), which was a critical error (Figure 1D). According to the percentage of patients performing all the basic steps of using the inhaler correctly, the major technical errors were more in using MDI than in the HandiHaler (relative risk of 1.6) based on Fisher exact test ($P<0.05$). Regarding, 62% of subjects using MDI performed at least one of the basic steps incorrectly. The relationship of patients' demographic characteristics with the techniques of using MDI and HandiHaler inhalers were calculated using the Chi-square test (Table 4).

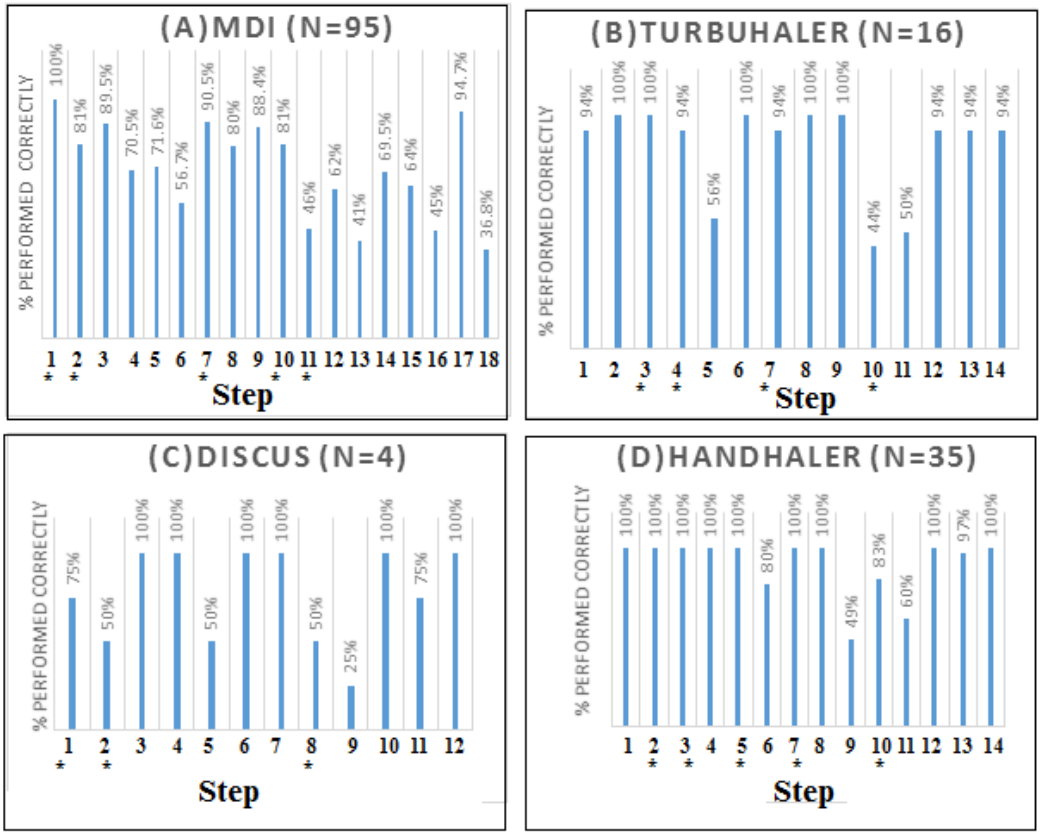

Figure 1. Steps for proper use of four types of inhalers based on the checklist
*Basic steps of applying a Turbuhaler inhaler

The regression between the significant variables on the correct use of MDI inhaler was calculated, which revealed that only the male gender (OR=1.034, P<0.05) and the referral reason (OR=0.379, P<0.05) were directly related to the correct use of the spray and were less misused.

Discussion

Due to the global prevalence of respiratory diseases, especially COPD, various efforts have been made to improve treatment methods with the help of various types of respiratory inhalers. Since awareness of technical problems is essential to improve community health, the researchers who examined the correct use of inhalers adopted different evaluation systems. Based on the findings reported by researchers, some methods merely evaluated the correct or incorrect use of inhalers. Moreover, they reported that in some studies the scoring system was based on the stages designed for each device. Therefore, these factors made it difficult to compare the results of various studies in this domain (7).

The current study specifically examined the patients with COPD. This disease is more common among elderlies who suffer from multiple disabilities, such as vision loss and tremors. Regarding the results of previous studies, such individuals would face more problems in caring for the disease and the proper use of inhaled medications (18).

Based on the findings of our study, a higher percentage of patients used MDI spray than other inhalers, which was consistent with the results of other studies. Accordingly, 62% of the subjects misused MDI at least in one of the basic steps of using the inhaler. In different studies, the percentage of this error was reported to be 65.7% (17), 86% (19), and 53.8% (20). The results of studies investigating the hospitalized patientsrevealed this percentage incredibly higher (93%) (15).

Table 4. Relationship of patients' demographic characteristics with the techniques of using MDI and HandiHaler inhalers

		Percentage of correct use of MDI frequency (%)	Percentage of incorrect use of MDI frequency (%)	P-Value	Percentage of correct use of HandiHaler Frequency (%)	Percentage of incorrect use of HandiHaler Frequency (%)	P-Value
Gender	**Male**	24 (57.1%)	18 (42.9%)	0.001*	11 (68.8%)	5 (31.2%)	**0.3**
	Female	12 (32.6%)	41 (77.4%)		10 (52.6%)	9 (47.4%)	
Occupation	**Employed**	16 (55.2%)	13 (44.8%)	0.02*	7 (77.8%)	2 (22.2%)	**0.2**
	Unemployed	20 (30.3%)	46 (69.7%)		14 (53.8%)	12 (46.2%)	
Education level	**Illiterate**	14 (25.9%)	40 (74.1%)	0.009*	10 (47.6%)	11 (52.4%)	**0.1**
	Under Diploma	20 (51.3%)	19 (48.7%)		9 (75%)	3 (25%)	
	Academic	2 (100%)	0 (0%)		2 (100%)	0 (0%)	
Duration of disease diagnosis	**<5 years**	27 (48.2%)	29 (51.8%)	0.01*	13 (72.2%)	5 (27.8%)	**0.1**
	≥5 years	9 (23.1%)	30 (76.9%)		8 (47.1%)	9 (52.9%)	
Duration of inhaler use	**<5 years**	28 (43.8%)	36 (56.2%)	0.09	15 (68.2%)	7 (31.8%)	**0.1**
	≥5 years	8 (25.8%)	23 (74.2%)		6 (46.2%)	7 (53.8%)	
Referral reason	**Periodic visits or receiving prescriptions**	22 (51.2%)	21 (48.8%)	0.01*	12 (66.7%)	6 (33.3%)	**0.7**
	Aggravated symptoms	14 (26.9%)	38 (73.1%)		9 (52.9%)	8 (47.1%)	
Smoking	**Yes**	4 (33.3%)	8 (66.7%)	0.6	2 (50%)	2 (50%)	**0.2**
	No	19 (43.2%)	25 (56.8%)		12 (75%)	4 (25%)	
	Quitted	13 (33.3%)	26 (66.7%)		7 (46.7%)	8 (53.3%)	
Types of used inhalers	**One**	18 (37.5%)	30 (62.5%)	0.9	-	-	**-**
	Multiple	18 (38.3%)	29 (61.7%)		-	-	
Spacer use	**Yes**	26 (38.2%)	42 (61.8%)	0.9	-	-	**-**
	No	10 (37%)	17 (63%)				

Table 5. Variables affecting the correct use of MDI spray

Variables	P-value	Odd Ratio	Confidence Interval (CI) 95%
Age	0.175	1.034	0.985-1.086
Gender (male)	0.033	0.243	0.067-0.890
Education level	0.989	0	0
Occupation	0.979	1.016	0.307-3.359
Duration of disease diagnosis	0.263	0.541	0.185-1.587
Referral reason	0.046	0.379	0.146-0.984

This higher percentage of error in using MDI is attributed to the difficulty of coordinating inhalation with actuation and patients' inability in performing this step and inadequate breath-holding and inappropriate fast inspiratory flow (6).The lack of adequate dose in the inhaler counter is reported to be another problem in its use (8). In some studies, the most common problems in the use of MDI were related to 'shaking the inhaler, exhaling before using the inhaler' and then 'holding the breath' (20). In the present study, the most common error that occurred in using MDI was the 'holding the breath' stage.

Some researchers believe that specialists do not routinely demonstrate the correct technique to patients; therefore, patients cannot learn the steps, leading to a high rate of technical errors in MDI use.For patients who are required to use MDI, it is reasonable to utilize this device with a spacer to reduce the need for inhalation and actuation coordination. The results of previous studies were indicative of the reduction of the rate of technical errors in using MDI with a spacer. Accordingly, this rate was obtained as 81% and 47% for with and without using a spacer, respectively (21, 22). However, in our study, no significant difference was observed regarding using the MDI spray with or without a spacer. This finding indicated that the use of a spacer itself requires training and it may be difficult for patients to use this device.

The main advantage of DPI over MDI is that since the aerosol of the drug is guided by the patient's breathing, there is no need to coordinate inhalation and actuation. However, if the patient is unable to breathe in properly, the drug may not be delivered to the lungs successfully (7). The literature review suggested the major technical error of DPI devices, such as Diskus, HandiHaler, and Turbuhaler, was the 'slow, deep inhale' step after using an inhaler (7, 15). Furthermore, it was found out that 'pushing the inhaler and then breath in deeply' was among the most difficult steps for patients, which was associated with a high error rate (20). In our study, in addition to the mentioned error, the patients were unable to perform the 'holding breath after using inhaler' step correctly.

In this study, the relationship between the basic characteristics of patients and technical errors was also investigated. It was revealed that the technical error rate was significantly lower among males, younger cases, participants with higher education, employed patients, and those who received appropriate training. In agreement with the results of other studies performed in this domain, the trainability rate was higher among men and younger individuals with higher education (23-25). Education level played an important role in the adopted technique of using inhalers (17). Patients with lower levels of education are less capable to properly understand and apply the written instructions on devices. Moreover, they have less knowledge about controlling and managing their disease. However, other factors, such as more referrals of these groups, can affect the result.

On the other hand, the results of several studies are not in line with those reported above (15, 20, 21). This discrepancy among the findings of this study with those of the recent ones can be associated with the different populations undergoing investigation. In the mentioned studies, a smaller sample size and only hospitalized patients were studied; therefore, they were not capable enough to identify such relationships and generalize their results to the whole population.

Implementation of results

In our study, patients were visited an average of about 6 times a year but these patients had received the training on correct inhalers application three times averagely. It was highly important that at each visit, patients had to be examined regarding the correct technique of inhaler use as part of the treatment process. Since individuals working in the healthcare sector are faced with a huge amount of workload, they always presume that the patient's previous training has been sufficient and that patients use the drug correctly. In a study in which most patients claimed that they used the inhaler correctly, it was revealed that 94.2% of cases had at least one technical error in performing that process (18). Therefore, it is required to checking the correct use of the drug and ensuring that the drug reaches the patient properly. In this respect, it would not suffice to merely ask the patient.

Limitations and strengths

One of the limitations of the present study was related to the objective observational evaluation of the appropriate amount of inspiratory flow. The observational evaluation is considered less accurate (26, 27). However, this issue was less influential in using DPI inhalers since the use of the HandiHaler device was accompanied by a specific rattling sound, which can be used to make sure of adequate breathing. In addition, patients may act differently from their routine and perform the steps more accurately when they are aware that they are being studied, which can lead to biased results. Due to the large number of patients in clinics, all patients couldn't cooperate more.

Iran, on the other hand, is a vast country where people with multiple accents and dialects refer to the clinics of tertiary hospitals. Occasionally, this language barrier prevented the proper transmission of the message to a number of patients; consequently, in this study, the focus was only on cases speaking Persian fluently. Finally, since DPI inhalers were more expensive than the other inhalers, fewer patients could use them one of the strengths of our study was that all the steps were checked by one person; as a result, the potential variation in the evaluation of the correct technique of using the inhaler performed by different evaluators was removed. Patients with different severity of COPD were evaluated in the clinics, which can be a more real representative of COPD patients.

Recommendations

It is suggested to use newer devices, such as the newly introduced HandiHaler, rather than the older devices, such as MDI, since they can deliver the same amount of medication to the lungs and require less coordination between hand movements and breathing. The results of some previous studies were indicative of the higher efficiency of these devices. (28). Since the incorrect technique of using inhalers has become prevalent. It is noteworthy that training programs should not be merely performed to transfer information to patients; rather, the changes in patient's behavior should be examined and achieved.

Conclusion

The improper technique of using inhalers is extremely common among COPD patients. Therefore, to achieve the purpose of proper caring for COPD patients, it is necessary to train and examine them regarding the correct use of inhalers. Otherwise, there might be such consequences as the lack of controlling the disease, the application of multiple drugs, and increased costs for individuals and the healthcare system.

Funding

This research received financial support from the Vice Chancellor for Research of Mashhad University of Medical Sciences.

Conflicts of interest

The authors declare that there is no conflict of interest.

References:

1. Vogelmeier CF, Criner GJ, Martinez FJ, Anzueto A, Barnes PJ, Bourbeau J, et al. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease 2017 Report. GOLD Executive Summary. American journal of respiratory and critical care medicine. 2017;195(5):557-82.

2. Lopez AD, Shibuya K, Rao C, Mathers CD, Hansell AL, Held LS, et al. Chronic obstructive pulmonary disease: current burden and future projections. The European respiratory journal. 2006;27(2):397-412.

3. Medicine GCRDCJTLR. Global, regional, and national deaths, prevalence, disability-adjusted life years, and years lived with disability for chronic obstructive pulmonary disease and asthma, 1990–2015: a systematic analysis for the Global Burden of Disease Study .2015 .691:(9)5;2017
4. Broaddus VC MR, Ernst JD, King TE, Lazarus SC, Murray JF, Nadel JA, Slutsky A, Gotway M. Murray & Nadel's Textbook of Respiratory Medicine E-Book. Elsevier Health Sciences; 2015 Mar 17.
5. Vestbo J, Hurd SS, Agustí AG, Jones PW, Vogelmeier C, Anzueto A, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. American journal of respiratory and critical care medicine. 2013;187(4):347-65.
6. Long-term oxygen therapy for patients with chronic obstructive pulmonary disease (COPD): an evidence-based analysis. Ontario health technology assessment series. 2012;12(7):1-64.
7. Lavorini F, Magnan A, Dubus JC, Voshaar T, Corbetta L, Broeders M, et al. Effect of incorrect use of dry powder inhalers on management of patients with asthma and COPD. Respiratory medicine. 2008;102(4):593-604.
8. Rau JL. Practical problems with aerosol therapy in COPD. Respiratory care. 2006;51(2):158-72.
9. Press VG, Arora VM, Shah LM, Lewis SL, Charbeneau J, Naureckas ET, et al. Teaching the use of respiratory inhalers to hospitalized patients with asthma or COPD: a randomized trial. 2012;27(10):1317-25.
10. Mahon J, Fitzgerald A, Glanville J, Dekhuijzen R, Glatte J, Glanemann S, et al.Misuse and/or treatment delivery failure of inhalers among patients with asthma or COPD: A review and recommendations for the conduct of future research. Respiratory medicine. 2017;129:98-116.
11. Dolovich MB, Ahrens RC, Hess DR, Anderson P, Dhand R, RauJL, et al. Device selection and outcomes of aerosol therapy: Evidence-based guidelines: American College of Chest Physicians/American College of Asthma, Allergy, and Immunology. Chest. 2005;127(1):335-71.
12. Paasche-Orlow MK, Riekert KA, Bilderback A, Chanmugam A, Hill P, Rand CS, et al. Tailored education may reduce health literacy disparities in asthma self-management. American journal of respiratory and critical care medicine. 2005;172(8):980-6.
13. Effing T, Monninkhof EM, van der Valk PD, van der Palen J, van Herwaarden CL, Partidge MR, et al. Self-management education for patients with chronic obstructive pulmonary disease. The Cochrane database of systematic reviews. 2007(4):Cd002990.
14. Chrystyn H, van der Palen J, Sharma R, Barnes N, Delafont B, Mahajan A, et al. Device errors in asthma and COPD: systematic literature review and meta-analysis. NPJ primary care respiratory medicine. 2017;27(1):22.
15. Batterink J, Dahri K, Aulakh A, Rempel C. Evaluation of the use of inhaled medications by hospital inpatients with chronic obstructive pulmonary disease. The Canadian journal of hospital pharmacy. 2012;65(2):111-8.
16. Mehuys E, Boussery K, Adriaens E, Van Bortel L, De Bolle L, Van Tongelen I, et al. COPD management in primary care: an observational, community pharmacy-based study. The Annals of pharmacotherapy. 2010;44(2):257-66.
17. Melzer AC, Ghassemieh BJ, Gillespie SE, Lindenauer PK, McBurnie MA, Mularski RA, et al. Patient characteristics associated with poor inhaler technique among a cohortof patients with COPD. 2017;123:124-30.
18. Beigoli S, Sharifi Rad A, Askari A, Assaran Darban R, Chamani J. Isothermal titration calorimetry and stopped flow circular dichroism investigations of the interaction between lomefloxacin and human serum albumin in the presence of amino acids. Journal of Biomolecular Structure & Dynamics. 2019;37(9):2265-2282.
19. Press VG, Arora VM, Shah LM, Lewis SL , Ivy K, Charbeneau J, et al. Misuse of respiratory inhalers in hospitalized patients with asthma or COPD. Journal of general internal medicine. 2011;26(6):635-42.
20. Lee H, Boo S, Lim Y, Kim S, Kim I-AJCnr. Accuracy of inhaler use in patients with chronic obstructive pulmonary disease. 2014;23(5):560-74.
21. Rootmensen GN, Van Keimpema AR, Jansen HM, de Haan RJJJoam, delivery pd. Predictors of incorrect inhalation technique in patients with asthma or COPD: a study using a validated videotaped scoring method. 2010;23(5):323-8.
22. Bosnic-Anticevich SZ, Sinha H, So S, Reddel HKJJoA. Metered-dose inhaler technique: the effect of two educational interventions delivered in community pharmacy over time. 2010;47(3):251-6.
23. Molimard M, Raherison C, Lignot S,Depont F, Abouelfath A, Moore NJJoam. Assessment of handling of inhaler devices in real life: an observational study in 3811 patients in primary care. 2003;16(3):249-54.
24. van Beerendonk I, Mesters I, Mudde AN, Tan TJJoA. Assessment of the inhalation technique in outpatients with asthma or chronic

obstructive pulmonary disease using a metered-dose inhaler or dry powder device. 1998;35(3):273-9.
25. Wieshammer S, Dreyhaupt JJR. Dry powder inhalers: which factors determine the frequency of handling errors? 2008;75(1):18-25.
26. Broeders ME, Molema J, Hop WC, Vermue NA, Folgering HTMJRm. The course of inhalation profiles during an exacerbation of obstructive lung disease. 2004;98(12):1173-9.
27. Danesh N, Navaee Sedighi Z, Beigoli S, Sharifi-Rad A, Saberi MR, Chamani J. Determining the binding site and binding affinity of estradiol to human serum albumin and holo-transferrin: fluorescence spectroscopic, isothermal titration calorimetry and molecular. Journal of Biomolecular Structure & Dynamics. 2018;37(7):1747-1763.
28. Dhar R, Salvi S, Rajan S, Dalal S, Tikkiwal S, Bhagat R, et al. Salmeterol/fluticasone through breath-actuated inhaler versus pMDI: A randomized, double-blind, 12 weeks study. 2015;.72-1065:(10)52