



ERRORS IN USING INHALER DEVICES AMONG COPD PATIENTS: A PROSPECTIVE COHORT STUDY

Respiratory Medicine

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ABSTRACT

Background: Pharmacological treatment of chronic obstructive pulmonary disease (COPD) is mainly based on inhaled medications. Inappropriate use of inhalers due to the unrecovered peak inhalation flow rate (PIFR) results in an increased risk of early treatment failure. Therefore, this study was carried out to address the error patterns in using dry powder inhalers (DPI) versus pressurized metered-dose inhalers (MDI) inhaler devices among COPD patients with acute exacerbation. **Methods:** For this prospective cohort study, a cohort of 138 COPD patients with acute exacerbation were included from a tertiary care hospital in Karnataka. The inhalation technique and PIFR were evaluated at discharge and twice in follow-up at 15-day and 90 days intervals based on a list of the most common errors in the inhalation techniques. **Results:** About 63% of patients had comorbidities. The average length of hospital stay was 7.8 days and the mean PIFR value at discharge was 58.9L/min. About 51.4% of the COPD patients were MDI users and 48.6% were DPI users. The most frequent errors were inappropriate inhaling and short breath holding time for DPI (89.6% and 88.1%) and MDI (84.5% and 94.3%) device users, respectively. At follow-ups, these errors- inhaling deeply and short-breath holding time continued to occur significantly during 90-day follow-ups for DPI (79.1% and 82.1%) and MDI (79.2% and 90.1%) device users, respectively. However, the breath-out and mouthpiece placing errors were reduced significantly at 90 days of follow-up among the DPI (50.7% and 40.3%, respectively) and MDI users (47.9% and 19.8%, respectively). **Conclusions:** Inappropriate inhaling and short breath holding time were the most frequent and major errors made by inhaler device users. This emphasizes the training in proper inhalation techniques for COPD patients treated with inhalers.

KEYWORDS

Chronic Obstructive Pulmonary Disease, Dry Powder Inhalers, Peak Inhalation Flow Rate, Pressurized Metered-dose Inhalers.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is an inflammatory airway disease that causes chronic progressive airflow obstruction. Tobacco smoking and biomass fuel smoke exposure are the main risk factors for the development of COPD. The pathology of COPD lies in the airways, lung parenchyma, and pulmonary vasculature. The pathological finding correlates with the pulmonary function testing parameters and clinical features. The Global Initiative for Chronic Obstructive Lung Disease (GOLD), defined COPD as —Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable, and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases and influenced by the host factors including the lung development. Emphysema and Chronic Bronchitis were previously classified as subtypes of COPD but now we do not use them. [1]

COPD is of high epidemiological concern as it stands fourth in position for its contribution to the total deaths worldwide. More than 3 million people died of COPD in 2012 accounting for 6% of death globally. [1] In 2016, 251 million cases of COPD were there in the world, and it is estimated that COPD causes 3.15 million deaths per year. [2]

The pharmacological treatment of COPD is mainly based on inhaled medications. Correct use of inhalers is essential: incorrect use is significantly associated with a high risk of acute exacerbation, hospital admission, visits to the emergency room, and a need for oral steroids and antimicrobials. [3–5] However, in the world, mishandling the inhaler, and poor adherence are common, even though most COPD patients are educated on the use of inhalers. [3,5,6]

Therefore, there is a continuous need to examine and assess the patients in their inhalation techniques. Hence, this study aimed to address the error patterns in using DPI vs pressurized MDI inhaler devices among COPD patients with acute exacerbation.

METHODOLOGY

Study Design

The study is a prospective cohort study done at 15 days follow-up and 90 days follow-up. The study was conducted at Sridevi Institute of

Medical Sciences and Research Hospital, Tumkur, Karnataka, India from July 2021 to April 2022. All the participants gave informed consent, and the study was approved by the institutional ethics committee.

Enrollment COPD patients admitted with acute exacerbation in the hospital and those who were followed up at the OPD level at 15 days post-admission and 90 days (three months)

Study Population

Inclusion Criteria

1. Those who gave informed consent.
2. Patients admitted to hospital with acute exacerbation of COPD 3. The age of the patients should be more than 40 years.

Exclusion Criteria

1. COPD patients who got admitted with tuberculosis, pneumonia, lung cancer, and pneumothorax.

Peak Inspiratory Flow meter

The patient keeps the mouthpiece in mouth and inhales through the mouth which causes air to be drawn through the meter and a cursor to move along the scale to indicate the speed of inhalation. The flow rate achieved can be noted by checking the position of the cursor against a calibrated scale. The best of three readings were captured on the day of discharge.

Steps used for MDI inhaler

- A. Dose must be prepared or loaded.
- B. Breathe out fully and gently, but not into the inhaler.
- C. The inhaler mouthpiece must be placed in the mouth and the lips must be sealed around the mouthpiece.
- D. Breathe in quickly and deeply.
- E. The breath must be held for up to ten seconds.

Steps used for DPI inhaler

1. The cap must be removed and shaken well.
2. Breathe out all the way.
3. The mouthpiece of the inhaler must be kept between the teeth and the lips must be sealed tightly around it.

- The canister must be pressed and breathing in should be continued as slowly and deeply as possible.
- The breath must be held for up to ten seconds.

The inhalation techniques (MDI and DPI), and PIFR were evaluated at discharge and twice in follow-up at 15 days and 90 days intervals based on a list of the most common errors in inhalation techniques.

RESULTS

Table 1: Basic characteristics of the patients (n=138)

Characteristics	Statistics
Age (years)	69.8 ± 7.5
Gender	
Male	87 (63.0%)
Female	51 (37.0%)
Smoking status	
Smokers	97 (70.3%)
Non-smokers	41 (29.7%)
Morbidities	
Comorbidities	87 (63.0%)
No comorbidities	51 (37.0%)
Inhaler user types	
MDI users	71 (51.4%)
DPI users	67 (48.5%)
Hospital length of stay (days)	7.8 ± 3.7

Age and hospital length of stay values are given in mean ± SD; Gender, Smoking status, Morbidities, and Inhaler user types response are given as n (%); DPI stands for Dry Powder Inhalers and MDI stands for pressurized Metered-Dose Inhalers.

Table 1 presents the basic demographic characteristics of the patients. The mean age of the patients was 69.8 years. About 63% of the patients were males and 37% were females. Almost 70% of the patients in our study were smokers. Comorbidities were reported among 63% of the patients. When assessing the types of inhalers that the studied patients were using, we found that 51.4% of them were MDI users and 48.5% were DPI users. The average length of stay at the hospital was recorded at 7.8 days.

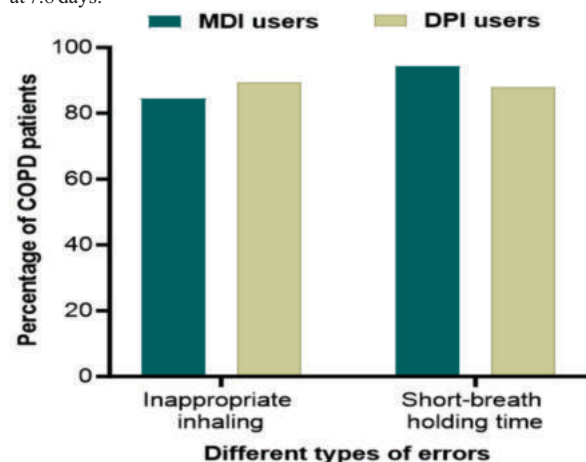


Figure 1: Comparison of different types of errors that occurred among MDI and DPI users.

Figure 1 shows the comparison of different types of errors that occurred among MDI and DPI users. The most frequent errors were inappropriate inhaling and short breath holding time for DPI (89.57% and 88.05%) and MDI (84.5% and 94.3%) device users, respectively.

Table 2: Dry powder inhaler (DPI) error percentage at discharge and at 90 days follow-up

	At discharge	90 days follow-up
Step 1: Load the dose	11.9	0.0
Step 2: Breath out fully	73.1	22.4
Step 3: Placing the inhaler	59.7	19.4
Step 4: Breathe in	89.6	79.1
Step 5: Hold your breath for 10 sec	88.1	82.1

Table 2 and Figure 2 (upper graph) show the error percentage comparison of the DPI users at the time of discharge and at 90 days of

follow-up. The marked decreases were observed for step 2 (breathing out fully) and step 3 (placing the inhaler rightly) whereas for steps 4 and 5 decreases were not much. About 12% of the DPI users could not load the dose properly at discharge but at the follow-up, all the patients were able to load the dose properly in the DPI device. Breathing out fully (22.4% vs. 73.1%) and the wrong placement of the inhalers (19.4 vs. 59.7%) were found to reduce significantly at the 90-day follow-up compared to at the time of discharge among the DPI users. However, improper breathing in and holding the breath for 10 seconds were the most frequent errors observed among the DPI users at the time of discharge (89.6% and 88.1%, respectively) and during the 90-day follow-up (79.1% and 82.1%, respectively).

Table 3: Meter Dose inhaler (MDI) error percentage at discharge and at 90 days follow-up

	At discharge	90 days follow-up
Step 1: Remove cap, shake well	43.7	9.8
Step 2: Breath out fully	71.8	23.9
Step 3: Placing the inhaler	61.9	42.2
Step 4: Press the canister, breath in	84.5	79.2
Step 5: Hold your breath for 10 sec	94.3	90.1

Table 3 and Figure 2 (lower graph) show the error percentage comparison of the MDI users at the time of discharge and at 90 days of follow-up. The marked decreases were observed for step 1 (remove the cap and shake well before use), step 2 (breathing out fully), and step 3 (placing the inhaler rightly) whereas for step 4 (Press the canister, breath in slowly and deeply) and step 5 (holding your breath for 10 sec) decreases were not noticeable. About 44% of the MDI users could not initiate the use properly by shaking well at discharge but at the follow-up, about 90% of the patients were able to initiate the MDI device for use properly. Breathing out fully (23.9% vs. 71.8%) was found to be reduced significantly at the 90-day follow-up compared to at the time of discharge among the MDI users. However, the wrong placement of the inhalers (42.2% vs. 61.9%) was found not to reduce markedly at the 90-day follow-up compared to at the time of discharge among the MDI users. Nevertheless, improper breathing in and holding the breath for 10 seconds were the most frequent errors observed among the MDI users at the time of discharge (84.5% and 94.3%, respectively) and during the 90-day follow-up (79.2% and 90.1%, respectively).

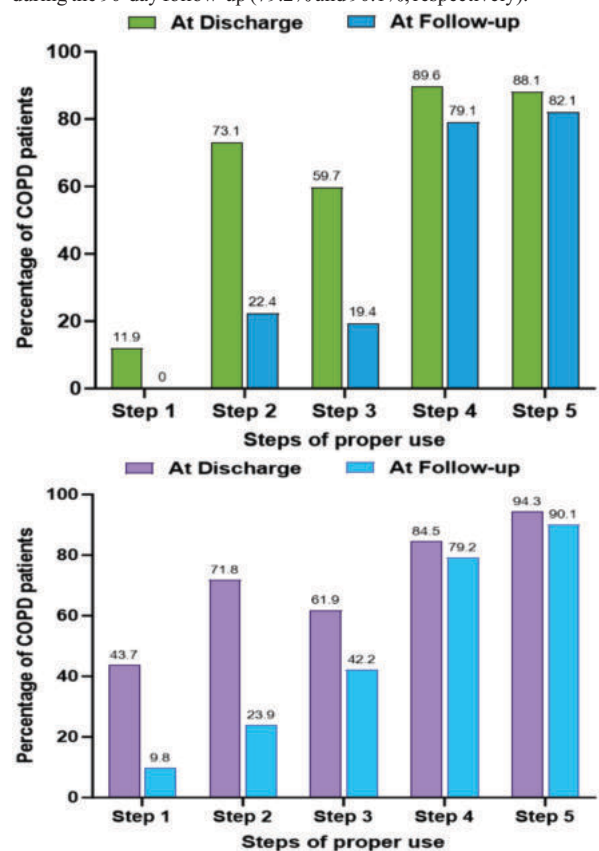


Figure 2: Error percentage at discharge and at 90 days follow-up of the DPI (upper graph) and MDI users (lower graph)

DISCUSSION

We compared the errors in the inhaler technique of all the patients enrolled in the study at discharge, first follow-up (15 days), and second follow-up (90 days) for both MDI and DPI devices. A total of 67 patients used DPI while 71 used MDI devices.

Ocakli et al. evaluated the errors in inhaler technique in stable COPD patients (n=328). They found for MDI devices, steps 1, 2, 3, 4, and 5 had got 57%, 75.8%, 17.5%, 43%, and 26% errors respectively. [7] Maximum errors were for step 2 and step 1 followed by steps 4 and 5, which was different from our study as the last two steps had the maximum errors. A similar result was found in our study that the second step of exhaling out was having almost a similar percentage of errors. The final two steps of deep inhalation and breath holding did not have many errors compared to our study. This may be because Ocakli et al. had taken subjects at the OPD level, who had stable COPD. For DPI devices (n=205), steps A, B, C, D, and E had 13.2%, 73.2%, 12.7%, 45.4%, and 19.5% errors respectively. Maximum error was for step B followed by step D. Almost a similar percentage of errors were there for the second step of exhaling out in our study and the fourth step of deep inhalation is the second most common committed error of technique in both the studies.

Castel-Branco et al. found for DPI devices (n=75), step 5 of holding breath had 68 % (n=51) errors followed by the exhalation step (step 2) which has 61.3 % (n=46) errors. [8] A total of 33.3 % (n=25) errors were there in step 4 of rapid inhaling. In MDI devices (n=16), the maximum error was for the final step (step E) of holding breath (62.5%) followed by step D of inhalation (43.8%), and 61.3% had errors in step B of exhaling out. Step A of shake well contributes to 37.5% errors. Like our study, Castel-Branco et al. also had maximum errors in the final step of the inhaler technique for both the devices and an almost similar percentage of errors in the exhalation step.

Believing that the main hindrance to treating patients with COPD successfully is incorrect inhalation technique. [9-11] Using any inhaler implies executing steps correctly and in an accurate order. If a patient makes a mistake, the amount of drug reaching the lungs can be significantly reduced, resulting in uncontrolled respiratory disease. [9,12] In the study, MDI was performed at a higher rate than DPI (26.6% and 18.2%, respectively accounting for both the number of inhalation techniques used and the number of individual steps). An observational study evaluating inhalation techniques in COPD patients conducted by Arora et al. in New Delhi also found that 82.3% of the 300 patients included in the study made an error, with 94.3% and 82.3% of MDI and DPI patients, respectively, having at least one error. [11] These results are the most expected outcomes of difficulty in using MDI and DPI.

CONCLUSION

Inappropriate inhaling and short breath holding time (steps 4 and 5) were the most frequent and major errors made by inhaler device users. Hence, we should assess the causes of non-improvement of the final steps of both devices such as more elderly population with reduced memory, eyesight/hearing disabilities, poor educational status, Low socioeconomic classes, family problems, etc. We should try adding Spacers with MDI devices to overcome these errors. This emphasizes the training in proper inhalation techniques for COPD patients treated with inhalers.

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