A cross-sectional study of pre- and posttraining evaluation of inhaler use technique among outpatients with bronchial asthma or chronic obstructive pulmonary disease at a tertiary care hospital in India

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Abstract

Context: Management of asthma and chronic obstructive pulmonary disease (COPD) includes use of inhalers as an integral component of drug delivery. Awareness about inhaler devices along with demonstration of the usage of inhaler technique aids in the optimization of therapeutic outcome.

Aim: This study aimed to assess the correct use of inhaler technique following pre- and posttraining sessions for the management of COPD and asthma among pulmonary outpatients at a tertiary care hospital.

Settings: This prospective cross-sectional study was carried out among patients diagnosed with asthma or COPD and prescribed with inhaler medication in the form of pressurized metered-dose inhaler (pMDI), MDI with spacer, or dry powder inhaler (DPI).

Subjects and Methods: The inhaler device use by the patients was assessed initially, followed by a demonstration on inhaler device technique, and reassessed post training using a checklist.

Statistical Analysis: Comparison of the median total score of pretraining and postraining inhaler technique was analyzed by Wilcoxon signed rank test. \( P < 0.05 \) was considered statistically significant.

Results: Out of 144 patients, 55.6%, 27.7%, and 16.7% of them were prescribed pMDI, MDI with spacer, and DPI, respectively. Post inhaler technique training, about 79.2% of the patients were able to demonstrate the inhaler technique correctly compared to 52.1% prior to training. A statistically significant difference in the median score of inhaler technique has been observed before and after training.

Conclusions: This study reports a significant improvement in the correct use of inhaler technique post training. In addition, the most frequent error among inhaler users was revealed to be in the breath actuation.

Keywords: Dry powder inhalers, metered dose inhalers, obstructive pulmonary disease

INTRODUCTION

Chronic respiratory illnesses such as chronic obstructive pulmonary disease (COPD) and bronchial asthma affect...
millions of people worldwide. The overall disease burden in relation to chronic respiratory diseases accounts for 6.4% in India, which is about 32% of the global disability-adjusted life years due to chronic respiratory diseases.[1]

Management of asthma and COPD includes use of inhalers as an integral component of bronchodilator and corticosteroid delivery.[2] The amount of medication delivered to the lower respiratory tract depends on the patient’s inhaler technique and also on the type of inhaler used.[3] Aerosol drug delivery devices used commonly are pressurized metered-dose inhaler (pMDI), MDI with spacer, and dry powder inhalers (DPIs).

Among many factors, insufficient patient education on proper inhalation technique also contributes to inadequate control of asthma.[4] Awareness about the inhaler devices along with demonstration of the usage of inhaler technique aids in the optimization of therapeutic outcome. Literature review has shown that only few studies had been done in India in this aspect. Hence, the objective of this study was to assess the correct use of inhaler technique following pre- and posttraining sessions for the management of COPD and asthma among pulmonary outpatients at a tertiary care hospital.

SUBJECTS AND METHODS

Study design and setting
This study was a prospective cross-sectional study carried out in the pulmonary medicine outpatients’ department of a tertiary care hospital for a period of 2 months in 2017. Prior institutional human ethics committee clearance was obtained. The study was conducted as per the Good Clinical Practice guidelines.

Study participants
All the outpatients aged >18 years, attending the pulmonary department and diagnosed with asthma or COPD and prescribed with inhaler medication in the form of pMDI, MDI with spacer, or DPI, were included in the study after

### Table 1: Sociodemographic and other characteristics of the study population

| Characteristics                      | Total (n=144) | Pretraining session | Posttraining session | P       |
|--------------------------------------|--------------|---------------------|----------------------|---------|
|                                      | n (%)        | Correct use, n (%)  | Incorrect use, n (%) |         |
|                                      |              |                     |                      |         |
| Age group                            |              |                     |                      |         |
| 18-29                                | 69 (47.9)    | 33 (47.8)           | 36 (52.2)            | 0.265   |
| 30-39                                | 46 (31.9)    | 17 (37)             | 29 (63)              | 0.407   |
| 40-49                                | 23 (16)      | 11 (47.8)           | 12 (52.2)            | 0.697   |
| 50-60                                | 6 (4.2)      | 0 (0)               | 6 (100)              | 0.383   |
| Gender                               |              |                     |                      |         |
| Male                                 | 106 (73.6)   | 47 (44.3)           | 59 (55.2)            | 0.383   |
| Female                               | 38 (26.4)    | 20 (52.6)           | 18 (47.4)            | 0.328   |
| Medical condition for which the patient uses inhaler device |              |                     |                      |         |
| Bronchial asthma                     | 110 (76.4)   | 49 (44.5)           | 61 (55.5)            | 0.395   |
| COPD                                 | 34 (23.6)    | 18 (53)             | 16 (47)              | 0.927   |
| Type of inhaler used                 |              |                     |                      |         |
| MDI                                  | 80 (55.6)    | 35 (43.7)           | 45 (56.3)            | 0.697   |
| MDI with spacer                      | 40 (27.7)    | 22 (55)             | 18 (45)              | 0.318   |
| DPI                                  | 24 (16.7)    | 10 (41.7)           | 14 (58.3)            | 0.256   |
| Duration of the illness (years)      |              |                     |                      |         |
| 1                                    | 24 (16.7)    | 10 (41.7)           | 14 (58.3)            | 0.205   |
| 2                                    | 49 (34)      | 18 (36.7)           | 31 (63.3)            | 0.507   |
| 3                                    | 14 (9.7)     | 4 (28.6)            | 10 (71.4)            | 0.257   |
| 4                                    | 31 (21.5)    | 18 (58.1)           | 13 (41.9)            | 0.299   |
| 5                                    | 26 (18.1)    | 17 (65.4)           | 9 (34.6)             | 0.386   |
| Number of times hospitalized due to exacerbation in the past 1 year |              |                     |                      |         |
| Not hospitalized                     | 75 (52.1)    | 32 (42.7)           | 43 (57.3)            | 0.793   |
| Hospitalized once                    | 42 (29.2)    | 15 (35.7)           | 27 (64.3)            | 0.339   |
| Hospitalized twice                   | 27 (18.8)    | 20 (74)             | 7 (26)               | 0.989   |
| Smoking history                      |              |                     |                      |         |
| Yes                                  | 95 (66)      | 45 (47.7)           | 50 (52.6)            | 0.318   |
| No                                   | 49 (34)      | 45 (91.8)           | 8 (16.3)             | 0.419   |
| Inhaler technique was first demonstrated by |              |                     |                      |         |
| Physician                            | 52 (36.1)    | 20 (38.5)           | 32 (61.5)            | 0.213   |
| Staff nurse                          | 59 (41)      | 24 (40.7)           | 35 (59.3)            | 0.407   |
| Pharmacist                           | 6 (4.2)      | 2 (33.3)            | 4 (66.7)             | 0.690   |
| Family member/friends                | 19 (13.2)    | 13 (68.4)           | 6 (31.6)             | 0.258   |
| Internet knowledge                   | 5 (3.5)      | 4 (80)              | 1 (20)               | 0.920   |
| Patient referred to package insert   | 4 (2.8)      | 2 (66.7)            | 2 (33.3)             | 0.304   |

COPD=Chronic obstructive pulmonary disease, MDI=Metered dose inhaler, DPI=Dry powder inhaler
obtaining prior written informed consent. Patients not willing to give consent and on acute exacerbation were excluded from the study. The confidentiality of the participants was ensured and maintained throughout the study.

**Study procedure**

A total of 170 patients were approached for participating in the study, out of which 144 patients consented to participate in the study. All the details such as sociodemographic characteristics, diagnosis, duration of the illness and the type of inhaler used, history of smoking, history of hospitalized requirement due to exacerbation in the past 12 months, and information regarding their knowledge on the inhaler usage were noted initially from the prescription of the participants. A checklist for the correct use of inhalational devices such as pMDI, MDI with spacer, and DPI based on the standards of National Institutes of Health guidelines was used for the assessment. The checklist was slightly modified according to the hospital’s standard procedure in inhaler technique.

**Table 2: Assessment of the technique involved in the use of pressurized metered-dose inhaler by the study population**

| Step                                                                 | Pretraining score (n=80) | Posttraining score (n=80) |
|----------------------------------------------------------------------|--------------------------|---------------------------|
|                                                                      | Correct, n (%)           | Incorrect, n (%)          | Correct, n (%) | Incorrect, n (%) |
| Remove the cap                                                       | 77 (96.2)                | 3 (3.8)                   | 80 (100)      | 0 (0)           |
| Shake the inhaler as directed                                       | 71 (88.7)                | 9 (11.3)                  | 79 (97.5)     | 2 (2.5)         |
| Hold the inhaler upright with the mouthpiece at the bottom with the thumb below the base and the finger on the top of the canister | 48 (60)                  | 32 (40)                   | 77 (96.2)     | 3 (3.8)         |
| Tilt your head back slightly, and breathe out slowly and completely away from the mouth piece | 57 (71.3)                | 23 (28.7)                 | 79 (97.8)     | 1 (1.3)         |
| Place the mouth piece between the teeth and close the lips           | 68 (85)                  | 12 (15)                   | 80 (100)      | 0 (0)           |
| As you start to breathe in, press down on the inhaler one time and continue to breathe in slowly and deeply for 3-5 s | 38 (47.5)                | 42 (52.5)                 | 67 (83.7)     | 13 (16.3)       |
| Hold the breath for 10 s                                            | 76 (95)                  | 4 (5)                     | 78 (97.5)     | 2 (2.5)         |
| Remove the inhaler from the mouth and breathe out slowly away from the inhaler. Wait for 1 min in the case of second dose | 72 (90)                  | 8 (10)                    | 80 (100)      | 0 (0)           |

**Table 3: Assessment of the technique involved in the use of metered dose inhaler with spacer inhaler by the study population**

| Step                                                                 | Pretraining score (n=40) | Posttraining score (n=40) |
|----------------------------------------------------------------------|--------------------------|---------------------------|
|                                                                      | Correct, n (%)           | Incorrect, n (%)          | Correct, n (%) | Incorrect, n (%) |
| Remove the cap of the inhaler and the spacer                         | 39 (97.5)                | 1 (2.5)                   | 40 (100)      | 0 (0)           |
| Shake the inhaler                                                     | 29 (72.5)                | 11 (27.5)                 | 40 (100)      | 0 (0)           |
| Attach the inhaler into the opening at the end of the spacer          | 33 (82.5)                | 7 (17.5)                  | 40 (100)      | 0 (0)           |
| Breathe out slowly, away from the mouth piece                        | 36 (90)                  | 4 (10)                    | 38 (95)       | 2 (5)           |
| Put the spacer mouthpiece into the mouth, close the lips around the mouthpiece | 39 (97.5)                | 1 (2.5)                   | 40 (100)      | 0 (0)           |
| Activate the inhaler by pressing down on canister 1 time             | 36 (90)                  | 4 (10)                    | 39            | 1 (2.5)         |
|                                                                      |                     |                           | 1 (97.5)      |                 |
| Breathe in deeply and slowly through your mouth                      | 27 (67.5)                | 13 (32.5)                 | 31            | 9 (22.5)        |
| Hold breath for 10 s                                                 | 33 (82.5)                | 7 (17.5)                  | 40 (100)      | 0 (0)           |
| Remove the spacer from the mouth and breathe out slowly away from inhaler. Wait for 1 min in the case of second dose | 39 (95)                  | 2 (5)                     | 40 (100)      | 0 (0)           |

**Table 4: Assessment of the technique involved in the use of dry powder inhaler by the study population**

| Step                                                                 | Pretraining score (n=24) | Posttraining score (n=24) |
|----------------------------------------------------------------------|--------------------------|---------------------------|
|                                                                      | Correct, n (%)           | Incorrect, n (%)          | Correct, n (%) | Incorrect, n (%) |
| Open the inhaler mouthpiece, or remove the cap                       | 24 (100)                 | 0 (0)                     | 24 (100)      | 0 (0)           |
| Place the capsule(s) in the inhaler and insert it into the Rotacap hole with its transparent end facing downward and rotate the base | 11 (45.8)                | 13 (54.2)                 | 23 (95.8)     | 1 (4.2)         |
| Breathe out fully, away from the inhaler                             | 11 (45.8)                | 13 (54.2)                 | 21 (87.5)     | 3 (12.5)        |
| Hold the inhaler as directed. Do not cover the vents. Place the mouthpiece between your lips | 24 (100)                 | 0 (0)                     | 24 (100)      | 0 (0)           |
| Take a fast, deep, forceful breath in through your mouth             | 10 (41.7)                | 14 (58.3)                 | 16 (66.7)     | 8 (33.3)        |
| Remove the inhaler                                                   | 20 (83.3)                | 4 (16.7)                  | 24 (100)      | 0 (0)           |
| Hold the breath for 10 s                                            | 23 (95.8)                | 1 (4.2)                   | 24 (100)      | 0 (0)           |
| Remove the inhaler from the mouth and breathe out slowly away from the inhaler. Wait for 1 min in the case of second dose | 17 (70.8)                | 7 (29.2)                  | 22 (91.7)     | 2 (8.3)         |
Later, the study participants were asked to demonstrate their prescribed inhaler device, which was assessed using the checklist regarding the usage of correct inhaler techniques by the investigator. This was taken as the pretraining score. Then, the correct use of inhaler technique was demonstrated using demonstration devices as a face-to-face training session by the same investigator to all the participants. After the training session, the participants were asked to attend the pulmonary outpatient department on the next day to re-demonstrate the procedure, which was again assessed for the correct steps in the use of inhaler by the investigator using the checklist. This was considered as the posttraining score. A score of “1” was allocated on the correct technique and “0” if incorrect for each step in the checklist on the use of inhaler devices. A total maximum score of “8” was given for pMDI and DPI inhaler devices and a maximum score of “9” for the MDI with spacer device.

Statistical analysis
Microsoft Excel was used for data entry and SPSS version 21 (IBM Corp., Armonk, NY, USA) for data analysis. Dependent variables were expressed as frequency and percentage. Binary logistic regression model was used to identify the factors that were associated with the dependent and independent variables. Comparison of the median total score of the pretraining and posttraining inhaler techniques was analyzed by Wilcoxon signed rank test. \( P < 0.05 \) was considered statistically significant.

RESULTS

Sociodemographic and other characteristics of the study population
The mean age of the included patients was 31.03 ± 8.8 years. Out of the 144 patients, about 110 (76.4%) and 34 (23.6%) patients were diagnosed with bronchial asthma and COPD, respectively. Majority (80 [55.6%]) of them were prescribed MDI, and 40 (27.7%) and 24 (16.7%) patients were using MDI with spacer and DPI, respectively. Before and after the training session, a statistically significant association was not observed between the use of inhaler technique and any of the characteristic factors mentioned in Table 1.

Table 5: Comparison of the median total score of pre- and posttraining session for each inhaler device

| Type of inhaler used | Median total score (IQR) | \( P^* \) |
|----------------------|---------------------------|----------|
|                      | Pretraining                | Posttraining |
| MDI                  | 5 (5-8)                   | 8 (8-8)  | <0.001 |
| MDI with spacer      | 9 (6-9)                   | 9 (9-9)  | <0.001 |
| DPI                  | 6 (4-8)                   | 8 (7-8)  | 0.001  |

\*Wilcoxon signed rank test. MDI = Metered dose inhaler, DPI = Dry powder inhaler, IQR = Interquartile range

DISCUSSION

In this study, more than half of the study participants (55.6%) were prescribed with pMDI. The most commonly prescribed type of inhaler is pMDI as the medication is delivered in a precise amount as aerosol on every single use and do not require rapid or forceful inspiration.[6]

During the pretraining session, about 58.4% of the participants demonstrated the usage of DPI incorrectly, which is consistent with that of previous studies.[7,8] The predominant incorrect step was “to take a fast, deep, forceful breath through mouth.” It is crucial that a rapid deep inhalation is taken to dissociate the medication and is forceful enough to deliver the dispersed powder to the lungs. After the training session on correct technique in the usage of the inhaler, the percentage of correct use increased from 41.7% to 66.7%.

Figure 1: Frequency of correct and incorrect inhaler users prior to training
Among the pMDI users, about 52.5% had their inhaler technique incorrect. The error most exhibited by them was in the step of “breathe in slowly and deeply while pressing down on the inhaler,” which is similar to that of the previous studies done in other countries as well. Furthermore, the most frequent error noticed in the use of MDI with spacer also pertained to breathing in slowly and deeply after pressing the canister. Although the breath actuation is not mandatory in an MDI with spacer, little or no delay is essential in coordination between inhalation and pressing the canister for effective delivery of the aerosol. An overall significant improvement in inhalation technique was observed following the face-to-face training to a percentage of about 83.7% in pMDI and 77.5% in MDI with spacer users from the pretraining inhaler use of 47.5% and 67.5%, respectively.

The demonstration of inhaler technique made a significant increase in the percentage of correct use of inhaler device, however about 20% of the patients made errors in the technique even after the training. Literature shows that long-term control of asthma is less in poor coordinators of actuation of canister with inhalation than those who use the pMDI correctly.

This study did not reveal any significant predictors in the correct use of inhaler, however male gender and education level have been the consistent strong predictors in the correct usage of inhaler devices.

The strength of the study is the inclusion of the inhaler technique for all types of inhaler devices frequently prescribed in the hospital. The limitations of the study are the cross-sectional design and that the study was conducted at a single center.

CONCLUSIONS

This study reports a significant improvement in the correct use of inhaler technique post training. Furthermore, periodic assessment and retraining on a regular basis maximize the effective usage of inhaler devices for optimum drug delivery among bronchial asthma and COPD patients.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.