Evaluation of relationship of inhaler technique with asthma control and quality of life
Bharti Chogtu, Sadhana Holla, Rahul Magazine, Asha Kamath

Abstract:
Introduction: There is a need to assess erroneous steps in the use of inhaler devices in people who have asthma. The objectives of this study were to assess the inhaler technique in patients who have asthma, the factors affecting improper technique, and the association of inhaler use with asthma control, hospital visits, and quality of life (QOL) of patients who have asthma.

Methods: It was an observational, prospective, cross-sectional study conducted on patients with bronchial asthma. Patients were enrolled in the study; their history was recorded and they were asked to use inhaler in the presence of an investigator and the technique was scored. Asthma control and QOL of patients were assessed using asthma control questionnaire and Mini Asthma QOL questionnaire.

Results: A total of 330 patients completed the study. Nearly 36.6% of the patients performed the steps incorrectly. Breathing normally for 30–60 min postinhaler use was the most common step done incorrectly. Patients with poorly controlled asthma (P < 0.001) and those with predicted forced expiratory volume at 1 s <70% performed the steps erroneously (P < 0.001).

Conclusion: All patients, particularly those above 40 years, should be given proper instructions regarding inhaler use to obtain therapeutic advantage.

Key words:
Asthma control questionnaire, inhaler technique, Mini Asthma Quality of Life Questionnaire

Asthma, a chronic inflammatory disease of the airway, is characterized by recurrent bouts of shortness of breath, chest tightness, wheezing and coughing in response to stimuli such as allergens, occupational irritants, drugs, and stress. About 300 million people are infected with this disease worldwide, and there is a 50% increase in prevalence for every 10 years.[1] The goals of asthma treatments are to reduce impairments such as uncontrolled symptoms, frequent use of rescue medication, limitation of activity, decreased quality of life (QOL), and risks such as hospital admission due to exacerbations and loss of lung function.[2] Due to its high global prevalence, large burden on patients, and high health-care costs, extensive research in the treatment of asthma is underway.

Majority of medications in asthma are administered through inhaler devices. Optimal drug delivery methods become critical in the management of asthma. As per the Global Initiative for Asthma (GINA) guidelines, the ability to deliver drugs directly to airways is a therapeutic advantage.[3] The correct technique and proper use of inhaler ensures effective delivery of drugs to lungs and thus affects the disease control. It is, therefore, imperative for patients with asthma to be educated about the disease and be skilled in inhaler use to improve the treatment outcome. In-depth knowledge about fallacies in inhaler use and its impact on asthma outcomes can be of great significance. Guidelines stress on inhaler technique and adherence to the extent that every recommendation about treatment adjustment includes a reminder to check inhaler technique and adherence at the outset.[4] Against this backdrop, the present study was planned to assess the inhaler technique in patients with asthma, the factors affecting improper technique, and the association of inhaler use with asthma control, hospital visits, and QOL of patients.

Address for correspondence:
Dr. Bharti Chogtu,
E-mail: bhartimagazine@gmail.com

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Methods

It was an observational, prospective, cross-sectional study conducted in patients with bronchial asthma. After obtaining clearance from the Institutional Ethics Committee (letter no. IEC-514/2013), the study was initiated. The study was carried out from November 2013 to March 2015 in the Department of Pulmonary Medicine in a tertiary care hospital. A written informed consent was taken, and patients were enrolled in the study as per the inclusion criteria.

Inclusion Criteria
These included:

- Patients presenting with acute exacerbation of bronchial asthma with peak expiratory flow (PEF) at randomization ≤75% of their known best (in the past 12 months) or in the absence of this information, ≤75% of their predicted PEF (predicted normal)
- Patients of both genders in the age group of 18 years and above
- Patients on inhaled corticosteroids and using metered dose inhalers (MDIs) for a period of at least 3 months (in addition to other drugs).

After enrollment, demographic data of patients, drug history, and information regarding inhaler device were recorded. The patients were asked to use inhaler in the presence of an investigator. As per the checklist,[9] the technique was scored by the investigator. Asthma control was assessed with a questionnaire which included seven questions.[10] Five of them included symptoms present at night, early in the morning, history of respiratory difficulty, wheezing, and limitation of activities. Questions on the frequency of usage of rescue therapy and on forced expiratory volume at 1 s (FEV1) completed the questionnaire.

The QOL of patients was assessed using “Mini Asthma Quality of Life Questionnaire (mini AQLQ).”[7] There were 15 questions in the questionnaire divided into four domains, which included assessment of activity limitation, symptoms of asthma, exacerbation due to environmental stimuli, and emotional disturbances due to the disease. The responses in asthma control and QOL were assessed for the questions as per the symptoms in the preceding 3 months.

Statistical Analysis
The data were analyzed using SPSS software version 16 (SPSS South Asia Pvt. Ltd., Bengaluru, Karnataka, India). Descriptive statistics were used to summarize the quantitative variables. The frequencies and percentages were used to evaluate categorical variables. Pearson’s Chi-square test was used to test the association between demographic and clinical characteristics across the variables regarding asthma inhaler technique. Multiple logistic models were used to identify the independent risk factors that were associated with the improper use of inhaler devices. The odds ratio with 95% confidence intervals was reported to describe the strength of these associations. *P* < 0.05 was considered statistically significant.

Results

A total of 330 patients were enrolled in the study. The mean age of patients was 51.54 ± 14.6 years and 57.3% of them were females. Homemakers constituted 45.5% of patients whereas 16.9% were professionals. Nearly 22.7% of the patients were uneducated and 17.9% and 17% of the patients were smokers and alcoholics, respectively. The clinical characteristics of the patients are shown in Table 1. The median duration of asthma was 120 months (48, 183). The drugs prescribed and comorbidities seen in the study population are shown in Table 2. FEV1 was ≥70% in 97 (30%) patients. Mean FEV1 in 1 s was 56.31 ± 20.22.

The median duration of inhaler use was 24 months. Of the total 330 patients using inhaler, 190 (57.5%) were using a spacer. Patients who had received education on inhaler technique constituted 87% of the total study population and 80.3% were following the prescription of MDI as directed by their physician.

Technique of Metered dose Inhaler in Patients
Improper technique for the use of inhaler was defined as <75% of the correct steps done[9] for each device. A total of 209 patients (63.4%) performed the steps properly.

| Diagnosis | n (%) | n=330 |
|-----------|-------|-------|
| Acute     | 40 (12.1) |
| Chronic   | 290 (87.9) |
| Duration of asthma (year) ≤ 1 | 20 (6) |
| Hospitalization | OPD visit | 73 (22.1) |
|            | Admission | 59 (17.9) |
|            | Educated on asthma | 151 (46) |
|            | Regular follow-up status | 232 (70.3) |

Values are expressed as n (%). *n*=Number of patients, OPD=Outpatient department

| Concomitant drugs | n (%) | n=330 |
|-------------------|-------|-------|
| Drugs prescribed  |         |       |
| Steroids          | 330 (100) |
| Beta-agonists     | 275 (83.3) |
| Anticholinergics  | 201 (60.9) |
| Methylxanthines   | 145 (43.9) |
| Leukotriene receptor antagonists | 259 (78.5) |
| Antihistamines    | 250 (75.8) |
| Antibiotics       |         |       |
| Oral              | 103 (31.2) |
| Parenteral        | 67 (20.3) |
| Comorbidities     |         |       |
| No comorbidity    | 165 (50) |
| Diabetes mellitus | 50 (15.1) |
| Hypertension      | 74 (22.4) |
| Hyperlipidemia    | 13 (3.9) |
| Allergic rhinitis | 53 (16) |
| GERD              | 3 (1) |

Values are expressed as n (%). *n*=Number of patients, GERD=Gastroesophageal reflux disease
From the 12 steps for the assessment of MDI with spacer, step 11 was incorrectly performed by 72.6% of the individuals, that is, breathing normally for at least 30–60 s postinhaler use. This was followed by step 4 (44.2%) and step 5 (43.2%) that included breathing out fully before inhalation and breathing out fully away from spacer, respectively, as shown in Figure 1. On assessing patients on MDI without spacer, step 11 and step 4 were incorrectly performed by majority of the patients.

Assessment of Asthma Control in Patients
Based on the scoring system, the number of patients was categorized into poorly controlled, partially controlled, and well-controlled asthma as shown in Figure 2.

All patients with well-controlled asthma had proper technique of inhalation. Patients with <70% of predicted FEV1 performed the steps improperly when compared to patients with predicted FEV1 ≥70% as shown in Table 3.

Regarding QOL, scores below 4 indicate a poor QOL. This score was observed in 160 individuals (48.5%). Rest of the patients had a score ≥4, indicating a good QOL. All domains of QOL were above 70% with the highest score in emotional domain and the lowest in environmental domain.

Relationship of Quality of Life with Inhaler Technique
Patients with improper technique of inhaler device had lower QOL scores with respect to all the domains in comparison with those having proper technique (P < 0.001).

Association of Metered dose Inhaler Technique with Demographic and Clinical Characteristics in Patients
The improper use of asthma inhaler devices was observed in 121 (36.6%) patients. Patients with age ≥40 years had a higher risk of improper inhalation technique compared to patients <40 years of age (P = 0.041). Gender, education, occupation, comorbidities, and other habits did not show any significant association with improper inhaler technique.

Patients who visited the outpatient department (OPD) and those who were admitted in hospital in the past 3 months had a higher risk of improper technique when compared to patients with no OPD visits or hospital admissions (P = 0.03). Patients who had received education on inhaler use (P = 0.001) and who were following regular prescription of inhaler use (P = 0.04) performed the steps properly in comparison to those who did not receive education and were not following prescription, respectively.

After controlling other risk factors, multivariable adjustment revealed that patients who lack education on inhaler device (P < 0.05) were more likely to use the asthma device improperly compared to those who received education. In addition, patients with poorly controlled asthma (P < 0.001) had a faulty technique and did not use the inhaler properly.

Discussion
The anti-asthmatic medications are administered through inhaler devices and their effectiveness in clinical practice can be affected by many factors. The amount of drug reaching the target organ is important for improved efficacy in the treatment of asthma. This in turn depends on the type of inhaler device, technique of inhalation, and patient’s compliance to inhalers. The common causes of uncontrolled asthma include incorrect inhaler technique in up to 80% of the patients[9] and at least 50% of the patients show poor adherence.[10] Proper technique of inhaler use improves disease outcome[11] and QOL.

Table 3: Relationship of inhaler technique with asthma control and predicted forced expiratory volume percentage in 1 s

| Characteristics                      | Levels                        | Proper technique | Improper technique | P     |
|--------------------------------------|-------------------------------|------------------|--------------------|-------|
|                                      |                               | 209 (63.3%)      | 121 (36.6%)        |       |
| Asthma control questionnaire          | Well-controlled asthma        | 7 (3.3)          | 0                  | <0.001* |
|                                      | Partially controlled asthma   | 149 (71.3)       | 9 (7.4)            |       |
|                                      | Poorly controlled asthma      | 53 (25.4)        | 112 (92.6)         |       |
| FEV1 (%)                              | <70                            | 126 (60.3)       | 105 (86.8)         | <0.001* |
|                                      | ≥70                            | 83 (39.7)        | 16 (13.2)          |       |

*P < 0.05 is significant. Values expressed as n (%). FEV1= Forced expiratory volume at 1 s
Of the total 330 patients, there was a female preponderance and most of the patients had been diagnosed with asthma for more than 1 year. All the patients were prescribed steroids, and a large number of patients (83%) were prescribed beta-2 agonists followed by antihistamines. Oral and parenteral antibiotics were prescribed to about 51.5% of the patients. Allergic rhinitis, hypertension, and diabetes were the common comorbidities seen in the patients.

More than half (57.5%) of the patients were using spacers. Various studies reveal that 8.6%, 14%, and 16.7% of the patients were using MDI devices with spacers.[13,14] In contrast to the present study, spacer devices were more frequently used. After two sessions of training, 48.5% of the patients failed to demonstrate the correct technique of inhaler use and therefore it becomes obligatory to improve the standard of care in patients with asthma.[19]

Almost 36.6% of the patients performed the inhaler technique incorrectly. Assessment of individual steps in inhaler technique revealed that 72.6% of the patients on MDI with spacer and 67.1% of the patients on MDI without spacer did not perform the step of “breathing normally for at least 30–60 s” postinhaler use. This was the most common step performed incorrectly in the study where a gap provided between the two actuations required the patients to breathe normally so as to prevent oropharyngeal deposition and allow the drug particles to reach the lower respiratory tract. This common error of not waiting for at least 30 s between inhalations has been reported by other authors.[16] In addition, it is considered as one among the seven essential steps of MDI technique.[16] Hence, a need to emphasize on this step for proper use of inhaler device is essential.

Another step performed incorrectly by patients was breathing out fully before inserting the mouth piece or breathing out fully away from the spacer in patients on MDI with spacer. In patients using MDI with spacer, the step of breathing out fully was incorrectly performed by 77% of the participants and breathing out away from the device was incorrectly performed in 83% of the participants.[17] About 50% of the patients do not perform the step of proper exhalation prior to inhalation.[19] Lack of proper exhalation prior to inhalation was one among the three most common errors in 25% of the inhaler users.[17]

Holding breathe for at least 10 s postinhalation, i.e., step 9 was done incorrectly in 42.6% of the patients. A study on patients using MDI without spacers found the maximum number of patients who exhaled incorrectly (65.88%) followed by breath holding (45.88%).[18] In another study, authors put forth that the major incorrect steps were not exhalation properly before inhalation (62%), not holding breathe correctly (57%), and not correctly shaking the inhaler (55%) for pressurized MDI.[18] Less than half (41.3%) of the patients adhered to the step of “breath holding for 10 s.”[20] An interesting finding from this study and previous studies suggests that the “breath holding for 10 s” is the step performed incorrectly or missed by most of the patients using MDI without spacer. This can be overcome by using MDI with spacer which is easier to use, does not need the breath-holding period, and is not affected by hand-breath incoordination.

According to the GINA guidelines, the goal of asthma management is to achieve clinical control. An important finding of this study was that patients with poorly controlled asthma (92.6%) compared to those with partially controlled asthma (7.4%) had a significant association with technique and are more likely to use asthma device improperly (P < 0.0001). Few other studies had similar findings where inhaler misuse was associated with an increased risk of poor asthma control.[9] Inhaler technique was also compared to ventilation capacity to know whether low FEV1% of predicted scores was associated with difficulty in using inhaler devices. On analysis, 86.8% of the patients with low FEV1% of predicted scores were found to perform the steps improperly. Low FEV1% of predicted scores indicates obstructive defect and thereby poor disease control, leading to difficulty in performing the right technique. However, in another study, low FEV1 was not associated with faulty inhaler technique.[10]

Asthma control measured by ACQ reflects the symptom and activity limitations. Studies assessing asthma control have found at least 50% of patients with poorly controlled asthma.[21] Another cross-sectional study constituted 24.6% of patients with controlled asthma, 46.3% with partially controlled asthma, and 29.1% with uncontrolled asthma.[22]

Asthma QOL measured by AQLQ correlates well with emotional and environmental aspects of the disease along with symptom and activity limitations. Mean AQLQ score was 5.6 ± 1.3 and cutoff score was set at 5.4[21] in comparison to the present study where the mean AQLQ score was 3.8 ± 0.57 and cutoff value was at 4. Asthma adversely affects physical, psychological, and social domains of QOL.[23] In the present study, environmental domain had a lower score of 71.93% followed by symptom domain (74.46%) and activity domain (77.04%). A study showed an improvement in all the domains of QOL, except environmental exposure.[24] Exposure to various stimuli such as cigarette smoke, dust, strong smells, air pollution, or weather changes affects environmental domain. The least influential domain was changes in emotional function (83.17%). Though studies claim that stress and negative emotions exacerbate the symptoms of asthma,[25] it was not seen in the present study due to proper counseling and reassurance by the physicians, and most probably, it can also be due to patients sharing their experiences with fellow patients suffering from the same disease.

Inhaler technique is affected by various factors. Age plays an important role in the incorrect technique. Patients in the age group ≥ 40 years (81.8%) performed the step improperly when compared to patients in the age group of < 40 years (18.2%). Similar findings were seen in a study, where maximum number of patients with incorrect technique belonged to the age group of 41–60 years.[23] Maximum errors (86%) were noted in the age group of 51–60 years.[19] Errors in elderly can be attributed to poor cognition and impaired vision. Education and regular reinforcement in all patients and more so in elderly is required to ensure a precise technique. A study comparing inhaler technique in adult and pediatric patients with asthmatics suggested that the former should be given supplemental instructions so that they take their medications properly.[26]

Uncontrolled asthma remains a frequent cause of emergency department (ED) visits and hospital admissions. The improper use of inhaler can cause uncontrolled asthma and frequent ED
visit. On analysis, a significant association ($P = 0.031$) was seen, where of the total patients performing technique correctly, 65% had no hospital visits, 20.6% visited OPD, and only 14.4% had admission in the past 3 months. Similar results have been reported by other authors.$^{[27]}$ Patients using inhaler devices inappropriately were at greater odds of visiting the ED in hospitals, compared to those with appropriate technique.$^{[28]}$

A large body of evidence suggests that inhaler technique can be improved by education from a health professional or other person trained in correct technique.$^{[29]}$ In our study, patients (91.9%) who received education were at a lower risk of making errors ($P = 0.001$). Studies suggest that as many as 25% of the patients with asthma had never received verbal inhaler technique instructions. Only an estimated 11% of the patients receive follow-up assessment and education on their inhaler technique.$^{[30]}$ Step-by-step instructions with repeated demonstrations of inhaler use and assessment of participant comprehension, i.e., teach-to-goal (TTG) strategy can be a beneficial step toward this. A hospital-based intervention through TTG results in fewer health-related events in asthma.$^{[31]}$

Medical care systems need to encourage and support adherence to treatment. Patients following regular prescriptions of MDI performed the technique perfectly in the present study and there was a statistically significant ($P = 0.040$) difference as compared to those not following the prescriptions. In a study where 233 patients were compliant with treatment, technical error was seen only in 15.8% of the patients.$^{[32]}$ Improvement in the technique with adherence to medications and regular prescriptions is seen. Multiple logistic regression analysis of variables that was significantly associated with improper inhaler technique revealed poorly controlled asthma and lack of education of inhaler device as significant predictors of improper inhalation technique ($P < 0.001$). Another recent study using regression model states that uncontrolled asthma and lack of education on asthma are associated with improper technique.$^{[33]}$

Thus, the present study puts forward the various factors associated with improper inhaler use which can reduce the delivery of required dose to the lungs. This in turn can attenuate the effectiveness of medication and can be a cause of therapeutic failure. One of the limitations of the study was that as it is a cross-sectional study, temporal sequence between the patients’ performance of the inhaler technique and the level of asthma control could not be established. Furthermore, as this study has been done in a single tertiary care hospital where patients are educated about the correct technique, it does not represent the inhaler practice at the national level. Hence, a multicentric study to assess inhaler technique and different aspects of asthma management is the requisite.

**Conclusion**

Breathing normally between two actuations, breathing out fully before inserting the mouth piece, or breathing out fully away from the spacer in patients on MDI with spacer were the erroneous steps in the use of inhaler. Poor control of asthma and insufficient information about inhaler are strong predictors for faulty technique of inhaler use. Improper technique in higher age groups makes it obligatory to stress on proper inhaler technique in this subset of patients.

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**Conflicts of Interest**

There are no conflicts of interest.

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