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Assessment of the inhalation technique and adherence to therapy and their effect on disease control in outpatients with asthma

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Abstract

Objectives The objective of this study was to assess correct use of inhaler devices, adherence to inhaler corticosteroid treatment and their effects on asthma control.
Methods This study was a prospective, single-centre, observational study conducted between July and February 2016 at Al-Makased Hospital, respiratory outpatient clinic. Inhaler technique of asthma patients using pressurized metered-dose inhalers or dry powder inhalers (Turbuhaler® (TH) and Accuhaler Diskus™ (ACC)) were assessed against published inhaler technique checklists. Asthma control variables measured using Asthma Control Test (maximum 25, higher score corresponding to better asthma control) were assessed, and adherence to asthma medications was assessed by Morisky adherence scale.
Key findings Two hundred and twenty patients were recruited in the study. The mean age was 42.3 ± 15.2 years and 59.1% were male. One hundred and seventeen (53.2%) were using TH, 60 (27.3%) were using ACC and 43(19.5%) were using MDIs. Only 22 (10%) were smoker and only 48 (21.8%) patients were their asthma controlled (ACT score >20). The devices were used correctly by 79.1% of patients using MDI, 69% of ACC and 55.6% of TH users ($P > 0.001$). The most common improper step was 'forceful inhalation' (65.4%) made by the MDI users, 'Not exhaling to residual volume' (58.7%) made by ACC users and 'Not inhaling deeply enough' (52.2%) made by TH users. Multivariate analysis showed that the likelihood of having controlled asthma was significantly higher in those with correct inhaler techniques (OR 2.3; 95% CI: 1.08–4.77; $P = 0.028$), high adherence to medications (OR 2.37; 95% CI: 1.05–4.92; $P = 0.03$) and having a higher level of education (OR 2.58; 95% CI: 1.19–3.63; $P = 0.018$).
Conclusions It was found that asthma control was better among correct users. Repetitive training about using devices may contribute improving inhaler technique.
Keywords adherence; Asthma Control Test; counselling; inhaler technique; Palestine; patient education

Introduction

Asthma is a chronic disease condition that causes major symptoms for the patient and affects livelihood, productivity and schooling with staggering cost for the healthcare system and cost of medications on community and individuals.[1,2] The number of asthma patients varies per country but in general, the prevalence can be as high as 5–23% in 'developed countries'.[3,4] Comparison of different studies in the Middle East indicates that the prevalence in rural Palestinian areas appears to be the lowest at 5.5% (as measured by 12 months wheezing rate),[5] while the highest prevalence was reported in Saudi Arabia desert population (23%).[6] In Palestine, the prevalence of recent wheezing was 8.9% and the prevalence of physician-diagnosed asthma was 3.8%.[5] Results from Jordan indicate a similar trend, where the prevalence for reported-wheezing was 8.3 and 4.1% for physician-diagnosed asthma.[4]

Patients commonly depend on inhalation devices during the maintenance phase of Asthma treatment. Pressurized metered-dose inhalers (pMDIs) and dry powder inhalers

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(DPIs) are the two types of devices commonly used by patients. Asthma control has been shown to be related to proper technique of inhaler use, with improper use resulting in poor asthma control, increased cost of treatment and more frequent hospital visits.[7–9] Side effects may also increase due to upper airway deposition of medication. This may result in overall patient dissatisfaction less than optimal response, ultimately resulting in poor medication adherence.[10,11] Specific steps need to be done when using an inhaler device; the steps need to be performed correctly to ensure optimal response.[12,13]

Approximately 75% of patients made at least one error with using an MDI and 50–60% of the DPI patients made one error at least.[14–16] Unfortunately, healthcare professional's ability to use asthma inhaler devices showing a similar propensity to patients for at least one error (13–80%).[17–19] This highlights the necessity for the healthcare provider to better understand inhaler techniques to allow them to pass the information to asthma patients.

The primary objective of the present study was to evaluate inhaler technique in outpatient asthma patient and the relationship to asthma control and patient's adherence to inhalers.

Materials and methods

Study design and subjects

This was a single-centre prospective observational study conducted at respiratory outpatient clinic of Al-Maqsed Hospital in East Jerusalem. The study was approved by Al-Maqsed Hospital institutional review board (PT-15/June/2015).

Patient's inclusion criteria included physician-diagnosed asthma, age >18 years and currently using one of the following inhalation devices: pressurized metered-dose inhaler (pMDI), Turbuhaler® (TH) or Accuhaler® (ACC). The devices contained maintenance medications (inhaled corticosteroids (ICS) with or without long-acting Beta agonist (LABA)) and patients having been on the device for at least 6 months. Study exclusion criteria included patients having cognitive impairment or suffering from a co-morbid condition. Before participating in the study, eligible patients signed an Informed Consent Form.

Asthma control

Asthma Control was defined as patients having no asthma symptoms, no limitation of daily activities, normal pulmonary function and no exacerbations.[20] ACT scoring system was used to measure asthma control; this system includes five questions, and the patient had to select one of five possible answers for each question.[21] Answers were assigned a score of 1–5, with a minimum total score of 5 and a maximum of 25. Patients with a score of 20 or higher are considered to be under control, while a total score of <20 are considered uncontrolled. The ACT scoring system is a commonly used tool in asthma research. The tool is distributed by GSK and is available in Arabic.[22,23] Verbal approval for the use of the ACT scoring system was obtained from the local GSK Office.

Inhaler technique assessment

The researcher with experience in inhaler technique education assessed inhalation technique in all patients using validated inhaler technique checklists for TH, ACC and pMDI. Each device had checklists of nine steps each; three steps were considered 'essential' for ACC and pMDI while TH had four essential steps (Table 1). The patient's technique was considered 'correct' if the required essential steps were performed accurately per inhaler and 'incorrect' if the essential steps were performed inaccurately or totally missed.[12,24,25] Once the trial assessments were completed, all patients were educated about the correct inhaler technique.

Adherence to control medications

The four Yes/No questions Morisky scale was used to measure adherence. The tool reflects the factors that affect

Table 1 Technique checklists for the DPIs and the pMDI*

Accuhaler™ (Diskus)	
Step	Description/action
1	Open inhaler†
2	Push lever back completely†
3	Exhale to residual volume
4	Exhale away from mouthpiece
5	Place mouthpiece between teeth and lips
6	Inhale forcefully and deeply†
7	Hold breath for 5 s
8	Exhale away from mouthpiece
9	Close inhaler
Turbuhaler®	
Step	Description/action
1	Remove the cap from the inhaler†
2	Keep inhaler upright†
3	Rotate grip until a click is heard†
4	Exhale to residual volume
5	Exhale away from mouthpiece
6	Place mouthpiece between teeth and lips
7	Inhale forcefully and deeply†
8	Hold breath for 5 s†
9	Exhale away from mouthpiece
pMDI	
Step	Description/action
1	Remove mouthpiece cover and shake†
2	Hold inhaler upright
3	Exhale to residual volume
4	Keep head upright or slightly tilted
5	Place mouthpiece between teeth and lips
6	Inhale slowly and press canister†
7	Continue slow and deep inhalation†
8	Hold breath for 5 s
9	Close the inhaler

DPI, dry powder inhaler; pMDI, pressurized metered-dose inhaler.
*These checklists and essential steps are in accordance with the literature.[12,24]
†Essential step: if not performed correctly, little/no medication will reach the lung.[25]

Table 2 Patients demographics and asthma management characteristics

Characteristics of patients	Turbuhaler (n = 117) (n, %)	Accuhaler (n = 60) (n, %)	pMDI (n = 43) (n, %)	P value
Female	72 (61.5)	34 (56.7)	24 (55.8)	0.78
Age (years)	43.8 ± 15.3	41.2 ± 13.1	39.5 ± 12.5	0.90
Duration of asthma diagnosis (years ± SD)	11.1 ± 6.6	8.9 ± 6.0	9.5 ± 6.8	0.66
Asthma control*				
ACT (controlled)	25 (21.4)	14 (23.3)	9 (20.9)	0.88
ACT (uncontrolled)	92 (78.6)	46 (76.7)	34 (79.1)	
Adherence†				
High adherence	72 (61.6)	35 (58.3)	25 (58.2)	0.90
Low adherence	45 (38.4)	25 (41.7)	18 (41.8)	
Inhaler technique score, mean ± SD	5.3 (0.9)	6.2 (0.8)	7.7 (0.9)	0.001
Smoker	11 (9.4)	9 (15.0)	4 (9.30)	0.66
Ex-smoker	53 (45.3)	29 (48.3)	22 (51.2)	
Non-smoker	53 (45.3)	22 (36.7)	17 (39.5)	
Education				
Primary education	9 (7.7)	1 (1.7)	9 (20.9)	0.04
Secondary education	48 (41.0)	33 (55.0)	18 (41.9)	
University/College	60 (51.3)	26 (43.3)	16 (37.2)	

*ACT score out of 25: ≥20 controlled; <25 uncontrolled asthma.
†Adherence scores can range from 0 and 4: scores of 0–1 (high adherence); scores of 2–4 (low adherence).

adherence: forgetting, carelessness, stopping when feeling better and stopping when feeling worse. On scoring of the questionnaire, each 'yes' response is given a score of 1 and each 'no' response is given a score of 0. As such, the adherence scores can range from 0 to 4; adherence classifications was either low adherence (scores of 2–4) or high adherence (scores of 0–1). Validity of Morisky self-report adherence scale has been well-established.[26] A pilot study was done on 10 patients from Al-Makassed hospital, Cronbach's Alpha for all 0.81 a good internal consistency and reliability.

A special form was used to capture data that included patient's name, sex, age, education, inhabitance, occupation, marital status and smoking habits. In addition, type of inhaler device used, education of inhaler technique and frequency of use were also collected. The study was conducted by a single investigator (trained in device use), in order to eliminate variability.

Statistical analysis

Data were collected and analysed by the computer software Statistical Package for Social Sciences Personal Computer (SPSSPC, Version 18.0. SPSS Inc, Chicago, IL, USA). The χ^2 test was used to compare categorical data. Mann–Whitney U-test was used for variables that were not normally distributed. Univariate logistic regression analyses were performed, the variables with P values <0.25 in univariate analyses were evaluated with multivariate analyses. Statistical significance was defined as P value <0.05 ($P < 0.05$).

Results

Two hundred and twenty patients were interviewed. Some demographic and clinical characteristics of studied patients are displayed in Table 2. The mean age of patients was 42.3 ± 15.3 years and 130 (59.1%) of patients were female. One hundred and seventeen (53.2%) were using Turbuhaler(T), 60 (27.3) were using Accuhaler® and 43 (19.5%) were using MDIs. Only 22 (10%) were smoker, and only 48 (21.8%) patients were under control as measured by ACT.

The majority of the patients (Accuhaler 82%, Turbuhaler 77% and metered-dose inhalers 71%) agree that the use of their inhalers is essential to manage their asthma symptoms, with no significant differences between inhaler groups ($P = 0.41$). The majority of patients reported obtaining information on inhaler techniques from their specialist (69%), followed by the hospital clinic (49%), with no significant difference between groups ($P > .0.05$).

Inhaler technique was correct in 79% of pMDI users, 69% of Accuhaler users and 55% of Turbuhaler users (Figure 1). Inhalation technique scores (of a total of 9 for all devices) were lower for Turbuhaler (5.3) and Accuhaler (6.2) compared to the metered-dose inhalers (7.7). A significant difference was found between the different inhaler groups ($P = 0.001$; Table 2).

Most common errors made by the MDI users were 'forceful inhalation' (65.4%), 'No/Short Breath hold' (63.5%). Accuhaler users were 'Not exhaling to residual volume' (58.7%), 'Exhale a way from mouthpiece', and Turbuhaler users were 'Not inhaling deeply enough' (52.2%; Figure 2).

More error was identified in old patients >60 years using a device for more than 5 years (87%) while minimum (51%) in young patients <40 years ($P < 0.05$). A comparison of education data showed patients with higher education committed less errors ($P < 0.05$).

Overall, only 21.8% of patients were classified as having controlled asthma (ACT score ≥20). ACT scores

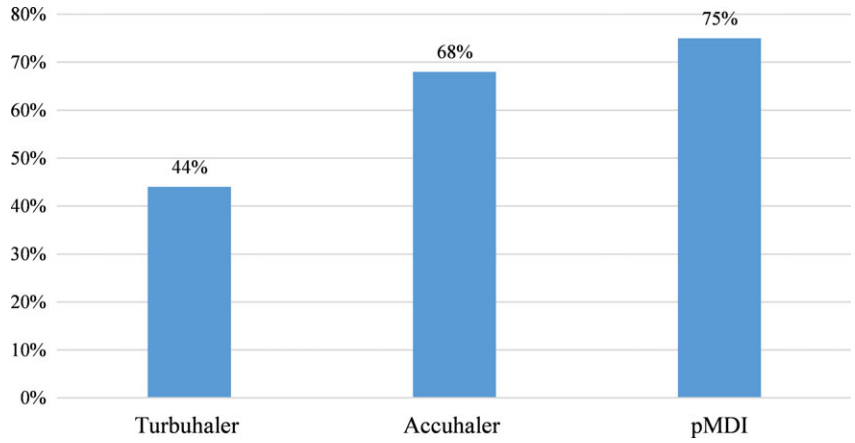

Figure 1 Percentage of correct inhaler users of each inhaler device.

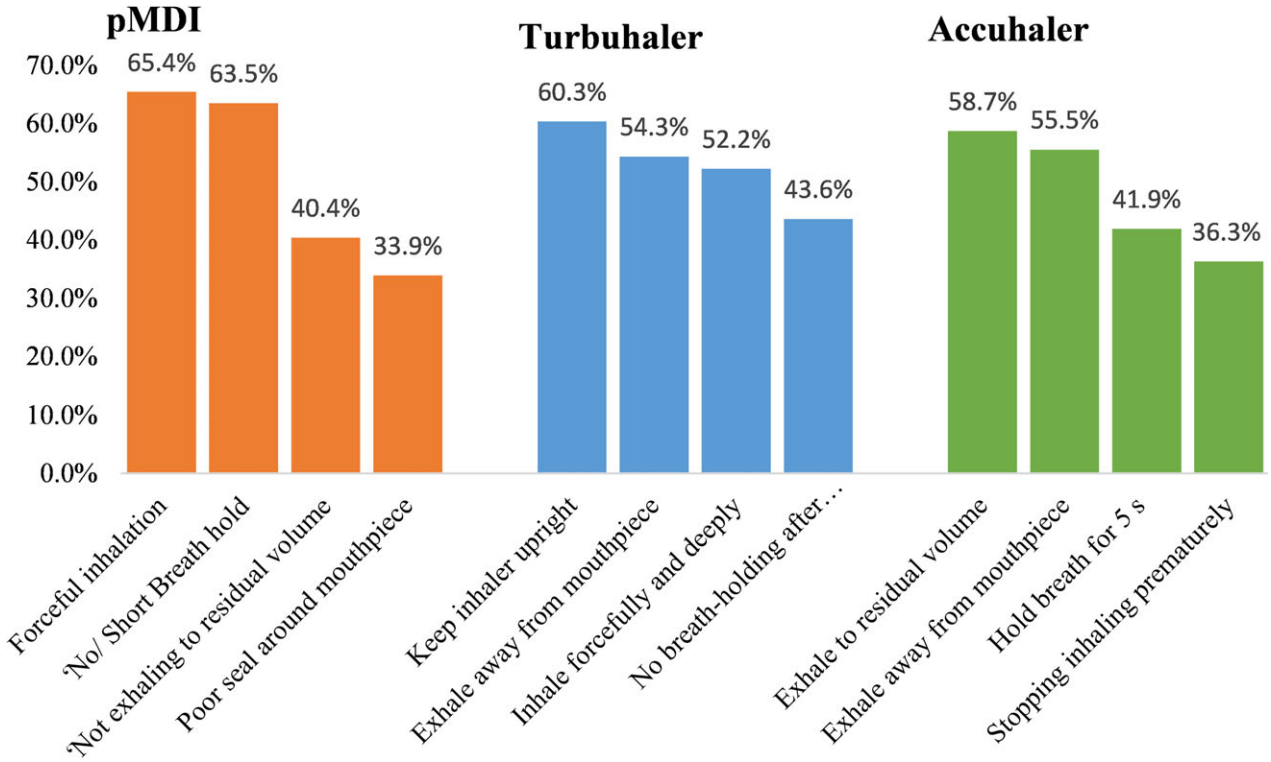

Figure 2 Most common errors made by the pressurized metered-dose inhalers users, Turbuhaler users and Accuhaler users.

showed no significant difference between the three device groups, disease duration or gender $P = 0.56$, 0.96, and 0.33 respectively (Table 2). Multivariate analysis modelling showed that having a higher level of education was significantly associated with having better asthma control (OR 2.58; 95% CI: 1.19–3.63; $P = 0.018$; Table 3).

Of the 48 patients with asthma control, 37 (77.1%) showed correct inhaler techniques. Similarly, 116 (67.4%) of the patients with poor inhaler technique had poor asthma control. Multivariate analysis showed that the likelihood of having controlled asthma was significantly higher in those with correct inhaler techniques (OR 2.3; 95% CI: 1.08–4.77; $P = 0.028$; Table 3).

Adherence to control medication was high in 135 (60%) and low in 88 (40%) of the participants. There were no significant differences in adherence between genders ($P = 0.34$). The most common causes reported of low adherence were 'forgetting to take the drug' (51.3%) and 'feeling well, doesn't need the drug' (25.5%).

Table 3 The variables affecting asthma control

Variable*	Univariate			Multivariate		
	OR	CI 95%	*P*	OR	CI 95%	*P*
Education status (Higher)	2.77	1.41–5.26	0.004	2.58	1.19–3.63	0.018
Inhaler technique (Correct)	2.35	1.25–4.39	0.007	2.32	1.08–4.77	0.028
Adherence (High)	2.25	1.22–4.36	0.011	2.37	1.05–4.92	0.030
Age >	1.51	1.10–2.44	0.041	1.32	0.66–2.88	0.311
Types of inhaler	1.22	0.73–2.51	0.568			
Disease duration >	1.09	0.55–1.78	0.969			
Gender (male)	1.33	0.71–2.81	0.338			

*Significant variables in univariate analysis were used in multivariate analyses.

A total of 29 (60.4%) of the patients with controlled asthma had high adherence to their control medications. Comparison of patients with low and high adherence, the latter were found more likely to have controlled asthma (OR 2.37; 95% CI: 1.05–4.92; $P = 0.03$, Table 3).

Discussion

Inhalational therapy constitutes the cornerstone of pharmacological management of asthma, metered-dose inhalers and DPIs are commonly used in stable patients, while in an acute attack physicians rely on administering the drugs via nebulization. Improper use of these devices can negatively affect their pulmonary delivery.[27] Therefore, in situations where the drugs are not taken as prescribed or do not reach the target area, it is likely that one might anticipate a poor treatment control.

Previous studies have reported on the frequency of correct use of inhaler technique among asthma patients.[28,29] In general, adequate performance was reported in 16.5–88% of asthmatic patients.[30,31] Similarly, the frequency of correct use of MDI and DPI devices were reported as 12–68%[32] and 21.8–88%[33] respectively. A critical at the available data suggests that the wide range of reported values may be attributed to differences between study population and definition of what is considered 'incorrect use'.

The present study showed that the main source of patient information about inhaler techniques comes from their specialist (69%), followed by the hospital clinic (49%). These data were consistent with data provided by Basheer *et al.*[34] in their study. The present study shows that 79% of the total enrolled patients committed at least one error during device usage. The data were consistent with another study where at least one error was committed by 82.1% of patients.[35] The most common errors were independent of the device used, which include failure to exhale before drug inhalation and failure to hold breath after inhalation. This is in line with findings from previous studies.[16]

The data also showed that old patients >60 years and those with poor or low education made maximum number of errors. Consistent with our findings, Melani *et al.*[36] observed inhalation technique of 1664 patients and found risk of critical errors increased with age. A study by Gracia *et al.*[37] that included 467 bronchial asthma patients observed increased risk of error with lower level of education. The finding above suggests that errors committed by patients during device use maybe attributed to the fact that the patient did not fully comprehend the instructions provided about inhaler technique. A more comprehensive training programme, keeping in mind the patient's education, age and level of comprehension, could address this issue.

One might anticipate that incorrect use of the inhalation device may result in insufficient drug delivery, which might negatively affect asthma control. On the other hand, correct use of inhaler devices improves asthma control in adults.[27,38] Accordingly, the data indicate that a higher frequency of asthma control can be observed in patients using their device correctly (OR 2.37; 95% CI: 1.05–4.92; $P = 0.03$). The importance of inhaler technique and its association with asthma control has been emphasized in the 2018 Global Initiative for Asthma strategy report[39,40] in which patients with incorrect inhaler technique were more likely to have poor asthma control.

In our study, 60% of patients showed high adherence to inhaler therapy. This percentage needs to be considered with caution because self-reported drug use does not always predict real adherence.[41] In previous studies among asthma patients, non-adherence rate ranged between 22.8 and 82.6%.[42,43] Adherence to ICS is essential to drug effectiveness. In present study, frequency of asthma control was found to be higher in patients with high adherence to prescribed ICS than patients of low adherence. This result is consistent with literature reports showing that improved patient adherence predicts superior asthma control and improved patient quality of life.[29,44,45]

Reasons for low adherence are multifactorial that may include social-, therapy- or patient-related factors.[45] In the current study, the most reported reason for low adherence was forgetting to take the drug. This issue should be discussed with the patient and can be easily addressed with modern technology (like computer-based applications or cellular phones) that provide ways to remind the patient to take the medication. Another reported reason for low adherence was if patients did not feel the need for the drug. Such intentional low adherence may be addressed by correcting patient misbelieves. Patient counselling with detailed discussion about perceptions of patients and caregivers will likely help.

Consistent with published data, the present study showed that asthma control could be predicted by older age at asthma onset and higher level of education. On the other hand, lower level of education or poor inhaler technique is associated with poor asthma control.[32]

Limitation

Medication adherence was measured using patient's survey. This method may not an objective measure of adherence. More ideal measure would have been parameters like canister weight, prescription refills, drug assays or electronic

monitoring.[6,27,38] Thus, responder's bias may limit findings about adherence to asthma treatment by inhalers.

Declarations

Conflict of interest

The Author(s) declare(s) that they have no conflicts of interest to disclose.

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Authors' contributions

All authors state that they had complete access to the study data that support the publication.

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