Importance of Inhaler Device Use Status in the Control of Asthma in Adults: The Asthma Inhaler Treatment Study

Fusun Yildiz MD, on behalf of the Asthma Inhaler Treatment Study Group*

BACKGROUND: Proper education and training in correct inhalation technique has been reported to have a substantial role in the achievement of optimal therapeutic benefit and asthma control. The present study was designed to evaluate inhaler technique and the role of education in relation to asthma control among patients with persistent asthma in Turkey. METHODS: A total of 572 patients with persistent asthma (mean ± SD age 42.7 ± 12.2 y, 76% females) were included in this non-interventional, observational, registry study conducted across Turkey. Data on the effective and correct use of inhaler devices were collected via the Ease of Use for the Inhaler Device Questionnaire to patients and physicians. RESULTS: Asthma control (overall 61.5% at baseline, and increased to 87.3% during follow-up) was better, with significant improvement in technique and decrease in basic errors to the range 0–1, regardless of the inhaler type. Overall, the most common basic error associated with inhalation maneuvers was failure to exhale before inhaling through the device (18.9%). There was concordance between the patients and physicians in the ratio of correct inhaler technique only for spray-type inhalers. CONCLUSIONS: Close follow-up with repeated checking of the patient's inhaler technique and correction of errors each time by a physician seem to be associated with a significant decrease in the percent of patients who make basic errors in inhalation maneuvers and device-independent errors, and with better control of persistent asthma. *Key words: persistent asthma; inhaler treatment; inhaler technique; asthma control; metered dose inhaler; dry powder inhaler.* [Respir Care 2014;59(2):223–230. © 2014 Daedalus Enterprises]

Introduction

Epidemiological data[1-3] on asthma show a low level of disease control in many countries, including Turkey. Therefore, finding the best way to assess asthma control and defining management strategies are the ongoing challenges in asthma management to ensure that asthma control is achieved and maintained.[4]

In line with the newly introduced asthma management approach, which emphasizes the monitoring of disease control to facilitate acceptance and use of asthma guidelines in

Dr Yildiz is affiliated with the Department of Pulmonary Diseases, Kocaeli University School of Medicine, Kocaeli, Turkey.

Supplementary material related to this paper is available at http://www.rcjournal.com.

This study was supported by a grant from Chiesi Pharmaceuticals, Turkiye. The authors have disclosed no conflicts of interest.

* The Asthma Inhaler Treatment Study Group (physician's names in descending order of number of patients enrolled): Yildiz F, Study Coordinator, Department of Pulmonary Diseases, Kocaeli University School of Medicine, Kocaeli; Erbagci A, Zonguldak Uzun Mehmet Chest Diseases Hospital, Zonguldak; Demirel YS, Department of Chest Diseases, Ankara University School of Medicine, Ankara; Akcali SD, Chest Diseases Clinic, Ankara Diskapi Yildirim Beyazit Hospital, Ankara; Ekici A, Department of Chest Diseases, Kirikkale University School of Medicine, Kirikkale; Dursunoglu N, Department of Chest Diseases, Pamukkale University School of Medicine, Denizli; Ediger D, Department of Chest Diseases, Uludag University School of Medicine, Bursa; Erdinc M, Department of Chest Diseases, Ege University School of Medicine, Izmir; Cemri SC, Chest Diseases Clinic, Mersin State Hospital, Mersin; Kalyoncu AF, Department of Chest Diseases, Hacettepe University School of Medicine, Ankara; Guclu SZ, Dr Suat Seren Chest Diseases Hospital, Izmir; Aktogu S, Dr Suat Seren Chest Diseases Hospital, Izmir; Bayram Gurler B, Chest Diseases Clinic, Derince Research and Training Hospital, Kocaeli; Bayram M, Chest Diseases Clinic, Sivas Numune Research and Training Hospital, Sivas; Akgun M, Department of Chest Diseases, Erzurum Ataturk University School of Medicine, Erzurum; Mirici A, Department of Chest Diseases, Canakkale 18 March University School of Medicine, Canakkale; Akyildiz L, Chest Diseases Clinic, Private Park Hospital, Mardin; Celik P, Department of Chest Diseases, Celal Bayar

clinical practice,[5] the use of combined therapies in which inhaled corticosteroids are given mainly in combination with long-acting beta-2 adrenoceptor agonists[5-7] has been recommended. However, correct inhalation technique plays a vital role in effective asthma therapy, alongside appropriate drug usage,[8] which otherwise may lead to diminished therapeutic effect, poor control of symptoms, and therefore insufficient disease management.[9]

There a limited number of validated questionnaires on inhaler techniques and a growing need for a valid and reliable measurement tool of patient preferences.

Given the substantial role of proper education and training in correct inhalation technique on the achievement of optimal therapeutic benefit[9] and the improvement documented in the measures of asthma control by interventions to correct inhaler technique in patients with asthma,[10] the present real-life prospective Asthma Inhaler Treatment Study was designed to evaluate patient inhaler technique and the role of education in relation to asthma control among patients with persistent asthma in Turkey, based on the Ease of Use for the Inhaler Device Questionnaire, completed by each investigator and patient, to enable subjective (patients' judgment of their inhaler technique) and objective (physicians' check) evaluation of inhaler technique.

Methods

Written informed consent was obtained from each subject, following a detailed explanation of the objectives and protocol of the study, which was conducted in accordance with the ethical principles stated in the Declaration of Helsinki and approved by the institutional ethics committee.

University School of Medicine, Manisa; Guven AO, Nihat Kitapci Chest Diseases Hospital, Erzurum; Camsari G, Yedikule Chest Diseases Hospital, Istanbul; Ozseker F, Sureyyapasa Chest Diseases Hospital, Istanbul; Cimen F, Ataturk Chest Diseases Hospital, Ankara; Kurutepe M, Sureyyapasa Chest Diseases Hospital, Istanbul; Senyigit A, Department of Chest Diseases, Dicle University School of Medicine, Diyarbakir; Bektas Y, Trabzon Chest Diseases Hospital, Trabzon; Ozbudak O, Department of Chest Diseases, Akdeniz University School of Medicine, Antalya; Saylan B, Chest Diseases Clinic, Umraniye Research and Training Hospital, Istanbul; Baslilar S, Chest Diseases Clinic, Umraniye Research and Training Hospital, Istanbul; Polatli M, Department of Chest Diseases, Adnan Menderes University School of Medicine, Aydin; Cagatay T, Department of Chest Diseases, Istanbul University School of Medicine, Istanbul; Kalkan S, Chest Diseases Clinic, Private Batman Hospital, Batman; Ozer A, Chest Disease Clinic, Cukurova State Hospital, Adana.

Correspondence: Fusun Yildiz MD, Department of Pulmonary Diseases, Kocaeli University School of Medicine, 41380, Kocaeli, Turkey. E-mail: fusun.yildiz@gmail.com.

DOI: 10.4187/respcare.02478

QUICK LOOK

Current knowledge

Proper patient education and training in inhaler use significantly improves medication delivery and symptom control in patients with asthma. There is wide variation in inhaler-use knowledge and technique among patients.

What this paper contributes to our knowledge

Regular monitoring of patient inhaler-use technique and correction of errors was associated with improved treatment adherence and asthma control. Regular reinforcement of inhaler technique requires clinician competence with various devices.

Study Population

Patients with persistent asthma were included in this national, multicenter, non-interventional, single-arm, prospective observational study conducted at 31 pneumology out-patient clinics across Turkey, based on 4 consecutive visits: at study enrollment (visit 1, month 0, $n = 572$), visit 2 (at 1 month, $n = 477$), visit 3 (at 3 months, $n = 368$), and visit 4 (at 6 months, $n = 308$), to determine asthma control status in relation to inhaler therapy and inhaler technique. We included out-patients $\geq$ 18 years old who were diagnosed with persistent asthma for at least the past 6 months, according to the Global Initiative for Asthma (GINA) criteria,[5] who had received at least one dose of inhaled corticosteroids and long-acting beta-2 agonists, either in separate or fixed combinations, irrespective of pharmacologic agent(s), and had been followed-up for at least 6 months prior to the study. We excluded patients with confirmed or suspected pregnancy; who were breastfeeding; who had comorbid COPD, allergy/sensitivity, or intolerance to any kind of asthma treatment; who had been on anti-immunoglobulin E treatment within the last 4 months; who had received treatment with leukotriene receptor antagonists; who had undergone hospitalization due to symptomatic respiratory infection within the past 8 weeks; who had any chronic diseases likely to negatively affect their prognosis (eg, carcinoma); or who had chronic alcohol or substance abuse.

Data Collection

At enrollment we collected data on age, sex, education, occupation, vital signs, physical examination findings, medical history, comorbidities, current therapies, characteristics and clinical course of asthma, and asthma control

and treatments. At baseline and at the 3 follow-up visits we administered the Ease of Use for the Inhaler Device Questionnaire, which we had developed specifically for each inhaler device. The Ease of Use for the Inhaler Device Questionnaire includes items on inhaler device type, appropriateness of the user's inhaler techniques, and patient adherence. The questionnaire (see the supplementary materials at http://www.rcjournal.com) was completed by each investigator and patient to assess subjective (patients' judgment of their inhaler technique) and objective (physicians' check) inhaler technique.

Asthma control was measured with the Asthma Control Test, which is a standard tool for assessing the patient's perspective on his or her asthma and asthma control level, and to predict exacerbations and to optimize asthma therapies.[11] The Asthma Control Test has been translated into Turkish, and cultural adaptation has been completed.[12] In the present study we administered the Asthma Control Test in the 4 weeks preceding the enrollment. We considered an Asthma Control Test overall score of ≥ 20 controlled asthma, and a score of < 20 uncontrolled asthma.

Statistical Analysis

The needed sample size was calculated to be 529 subjects to test the hypothesis that the rate of controlled asthma is 25% within 95% CI and with ± 3.5% accuracy. We assumed there would be a 20% drop-out rate, and therefore included 635 subjects.

The analyses were conducted with statistics software (Stata10, StataCorp, College Station, Texas). Data are expressed as mean ± SD or number and percent. Categorical comparisons between the groups were evaluated via the chi-square test, using cross-table statistics. All tests were 2-sided, and $P < .05$ was considered statistically significant.

Results

Patient Demographics

The subjects' mean ± SD age was 42.7 ± 12.2 years, and 435 (76%) were females. Four-hundred forty (76.9%) were primary-high school graduates, 61.9% were unemployed, and 55.8% were housewives (Table 1). The mean ± SD duration of asthma from diagnosis was 8.0 ± 8.3 years, and 53.3% had been diagnosed with asthma ≤ 5 years ago. One-hundred four subjects (18.2%) were active smokers.

Table 1. Socio-Demographic Characteristics of Patients

n	572
Age, mean ± SD y	42.7 ± 12.2
Age category, no. (%)	
18–40 y	252 (44.1)
41–60 y	272 (47.6)
> 60 y	48 (8.4)
Male, no. (%)	137 (24.0)
Female, no. (%)	435 (76.0)
Years since asthma onset, mean ± SD y	8.0 ± 8.3
Years since diagnosis category, no. (%)	
≤ 5 y	305 (53.3)
5–10 y	118 (20.6)
10–15 y	59 (10.3)
> 15 y	90 (15.7)
Active smoking, no. (%)	104 (18.2)
Education, no. (%)	
Illiterate	28 (4.9)
Primary-high school	440 (76.9)
University	104 (18.2)
Employment, no. (%)	
Unemployed	354 (61.9)
Employed	210 (36.7)
Missing	8 (1.4)

Inhaler Device Preferences in Relation to Age and Education Level

The percentages of patients adherent to their inhaler device without need of treatment switch for the Diskus, Turbuhaler, solution spray (Pressurized Metered Dose Inhaler [pMDI]), and Aerolizer inhalers were 30.0%, 29.9%, 21.0%, and 17.3% at baseline, and 28.0%, 31.3%, 20.8%, and 19.9% at the final visit, and there was no significant difference between visit 1 and visit 4. Solution spray was the most preferred device: used by 52.7% of all patients, and also among all age and education subgroups at baseline (Table 2). Inhaler use was evenly distributed across the age subgroups for all inhaler types, but there was a significant relationship between education and Diskus and Turbuhaler use ($P = .002$ and .01, respectively). Diskus was determined to be more commonly preferred among illiterates, whereas Turbuhaler was more commonly preferred among university graduates (see Table 2).

Asthma Control Status From Baseline to Last Visit in Terms Inhaler Treatment

Overall, asthma was controlled in 61.5% of the patients at baseline, and increased to 87.3% during follow-up. When compared to baseline, the rate of uncontrolled asthma was significantly decreased at visit 4 in patients using fixed-dose drug-combination devices: fluticasone/salmeterol in Diskus 38.2% vs 11.4%, $P < .001$; beclomethasone/formoterol in solution spray 32.7% vs 10.0%, $P < .001$; budesonide/formoterol in Turbuhaler 41.7% vs 14.9%, $P < .001$. There was no difference in the uncontrolled asthma rate with the use of budesonide + formoterol with the Aerolizer (separate inhaler devices): 42.9% vs 23.5%, $P = .13$ (Table 3).

Table 2. Inhaler Device Preferences in Relation to Age and Education Level

	Solution Spray (controller + rescue)		Diskus		Turbuhaler		Aerolizer	
	no. (%)*	P†	no. (%)*	P†	no. (%)*	P†	no. (%)*	P†
Age category								
18–39 y (*n* = 236)	128 (54.2)		64 (27.1)		73 (30.9)		37 (15.7)	
40–59 y (*n* = 285)	151 (53.0)	.49	90 (31.6)	.38	84 (29.5)	.87	52 (18.2)	.67
> 60 y (*n* = 51)	23 (45.1)		18 (35.3)		14 (27.5)		10 (19.5)	
Total	302		172		171		99	
Education								
Illiterate (*n* = 28)	16 (57.1)		17 (60.7)		2 (7.1)		6 (21.4)	
Primary-high school (*n* = 440)	231 (52.5)	.85	134 (30.5)	.002	132 (30.0)	.014	76 (17.3)	.82
University (*n* = 104)	55 (52.8)		28 (20.2)		37 (35.6)		17 (16.3)	
Total	302		179		171		99	

* Percent of all patients in the age/education subgroup.
† Via chi-square test.

Table 3. Asthma Control Status in Relation to Inhaler Types Assessed by Physicians

	Visit 1 (month 0)			Visit 4 (month 6)			P†
	Total (*n* = 572)	Asthma Control Status		Total (*n* = 308)	Asthma Control Status		
		Controlled* (*n* = 352)	Uncontrolled (*n* = 220)		Controlled (*n* = 269)	Uncontrolled (*n* = 39)	
Fixed-dose combination inhalers							
Diskus: fluticasone propionate + salmeterol	152 (26.6)	94 (61.8)	58 (38.2)	79 (25.6)	70 (88.6)	9 (110.4)	< .001
Solution spray: beclomethasone dipropionate + formoterol	107 (18.7)	72 (67.3)	35 (32.7)	60 (19.5)	54 (90)	6 (10.0)	< .001
Turbuhaler: budesonide + formoterol	156 (27.3)	91 (58.3)	65 (41.7)	87 (28.2)	74 (85.1)	13 (14.9)	< .001
Separate inhalers							
Aerolizer: budesonide + formoterol	84 (14.7)	48 (57.1)	36 (42.9)	51 (16.6)	39 (76.5)	12 (23.5)	.13
Easyhaler: budesonide + formoterol	21 (3.8)	14 (66.7)	7 (33.3)	8 (2.6)	8 (100)	0 (0)	‡

Values are number (%).
* Controlled = Asthma Control Test score ≥ 20. Uncontrolled = Asthma Control Test score < 20.
† *P* via chi-square test for rate of uncontrolled asthma at visit 1 vs at visit 4.
‡ No statistical analysis because of the small number of patients.

Basic Errors in Inhaler Technique Throughout the Study, According to Inhaler Type

Overall, at baseline, failure to exhale before inhaling through device was the most common (18.5%) error in inhalation maneuvers, mostly with Aerolizer (28.9%) and Diskus (20.6%). Exhalation during the inhalation maneuver was common with Turbuhaler (14.1%) and Diskus (11.4%). Failure to rinse the mouth after inhaling the drug was the leading (16.8%) device-independent error (Table 4).

Among the most common inhaler-device-specific errors, failure to exhale before the inhalation maneuver was very common with Aerolizer (28.9%) and Diskus (20.6%), exhalation during the inhalation maneuver was more frequent with Turbuhaler (14.1%) than Diskus (11.4%), and failure to breath-hold was common with all the inhalers (most common with Aerolizer, at 18.7%, see Table 3).

After physician training there was a significant decrease in basic errors in inhalation technique identified by patients, including failure to exhale before inhaling through the device (18.5% at visit 1 vs 6.5% at visit 4, $P < .001$), failure to hold breath for 5–10 seconds after the inhalation (13.6% at visit 1 vs 3.7% at visit 4, $P < .001$), and failure to rinse the mouth with water after inhaling the drug (16.8% at visit 1 vs 5.6% at visit 4, $P < .001$) (see Table 4).

Table 4. Basic Errors in Inhaler Technique in Relation to Inhaler Type

	Failure to Exhale Before Inhaling Through the Device			Exhalation During Inhalation			Failure to Hold Breath for 5–10 Seconds After Inhalation			Failure to Rinse Mouth With Water After Inhaling the Drug		
	n/N	(%)	*P*	*n/N*	(%)	*P*	*n/N*	(%)	*P*	*n/N*	(%)	*P*
Solution spray												
Visit 1	9/88	(10.2)	.12	4/88	(4.5)		11/90	(12.2)	.18	13/89	(14.6)	.42
Visit 4	1/42	(2.4)		0/41	(0)		2/42	(4.8)		4/42	(9.5)	
Diskus												
Visit 1	27/131	(20.6)	.07	15/132	(11.4)	.16	18/132	(13.6)	.16	27/132	(20.5)	.14
Visit 4	6/60	(10.0)		3/60	(5.0)		4/60	(6.7)		7/60	(11.7)	
Turbuhaler												
Visit 1	23/144	(16.0)	.02	20/142	(14.1)	.01	17/145	(11.7)		25/145	(17.2)	
Visit 4	3/69	(4.3)		2/69	(2.9)		0/69	(0)		0/69	(0)	
Aerolizer												
Visit 1	22/76	(28.9)	.01	7/76	(9.2)	.33	14/75	(18.7)	.03	9/75	(12)	.06
Visit 4	4/45	(8.9)		2/45	(4.4)		2/45	(4.4)		1/45	(2.2)	
Total												
Visit 1	81/439	(18.5)	< .001	46/438	(10.5)	.15	60/442	(13.6)	< .001	74/441	(16.8)	< .001
Visit 4	14/216	(6.5)		7/215	(3.3)		8/216	(3.7)		12/216	(5.6)	

Asthma Control Status in Relation to Number of Basic Errors in Inhalation Technique

Based on the data from the physician and patient questionnaires, the number of basic errors decreased to 0–1, and asthma control increased with all the inhaler devices (Table 5). The patient and physician questionnaires were compatible in terms of percent of controlled and uncontrolled asthma with 0–1 error at visit 1 and visit 4 (see Table 5).

Past Training on Inhaler Technique and Arbitrary Dose-Adjustment By Patients

The majority of patients reported that they had learned inhaler technique from a specialist physician, for all the inhaler types, and that percentage increased from visit 1 to visit 4, whereas the percentage of pharmacists, nurses/physiotherapists/technicians, family physicians, and relatives/friends reported as inhaler trainers decreased from visit 1 to visit 4 (Table 6).

Practice-based learning was more common than theory-based learning for each type of inhaler, and there was a gradual increase in favor of practice-based learning during the study. About one third of the patients reported that their inhaler technique was not checked by a trainer, but this percentage decreased during the study (see Table 6).

Discussion

Our principal finding is improved asthma control and better patient adherence with fixed-dose drug-combination inhalers, in Turkish patients with persistent asthma, and that the most common errors in inhalation technique were failure to exhale before the inhalation maneuver (18.5%), exhalation during the inhalation maneuver (10.5%), and failure to breath-hold after the inhalation maneuver (13.9%). During the study there was significant improvement in correct technique for Turbuhaler and Aerolizer, and better asthma control and fewer basic errors (down to range 0–1) for all the inhalers.

International guidelines for the management of COPD do not differentiate between various inhaler devices,[13] but instead indicate that device selection should be based on availability, cost, patient and physician preference, and clinical setting.[10] Accordingly, fixed-dose drug-combination inhalers were equally effective in asthma control in our patients, and the uncontrolled asthma rate had decreased at 6 months.

The majority of our patients had good adherence to their asthma inhalers during follow-up and satisfaction with the relief provided, which indicates the importance of close follow-up in asthma control and emphasizes the bi-directional positive relationship between asthma control and treatment satisfaction.

Given that our patients had had asthma for an average of 8 years, the finding that basic errors in inhaler technique ranged from 10.5% to 18.5% at baseline is noteworthy. Likewise, failure to rinse the mouth with water after inhaling the drug was the most commonly identified device-independent error, and no significant improvement was obtained with any of the inhaler types.

Increase in asthma control rate by appropriate inhaler use is critical, given that, although inhalers' technical features have improved, their effectiveness in delivering drugs

Table 5. Asthma Control Status in Relation to Number of Basic Errors in Inhalation Technique

	Visit 1, no. (%)		Visit 4, no. (%)		*P**
	0–1 Error	> 1 Error	0–1 Error	> 1 Error	
Physician questionnaires†					
Aerolizer					
Score‡ ≥ 20	42 (59.2)	11 (68.8)	41 (82.0)	1 (100)	.008
Score < 20	29 (40.8)	5 (31.2)	9 (18.0)	0 (0)	
Diskus					
Score ≥ 20	72 (66.1)	22 (51.2)	55 (88.7)	3 (60.0)	.001
Score < 20	37 (33.9)	21 (48.8)	7 (11.3)	2 (40.0)	
Solution spray					
Score ≥ 20	13 (61.9)	49 (62.8)	17 (10.0)	20 (90.9)	< .001
Score < 20	8 (38.1)	29 (37.2)	0 (0)	2 (9.1)	
Turbuhaler					
Score ≥ 20	82 (58.6)	19 (61.3)	70 (85.4)	1 (100)	< .001
Score < 20	58 (41.4)	12 (38.7)	12 (14.6)	0 (0)	
Patient questionnaires*					
Aerolizer					
Score ≥ 20	37 (61.7)	17 (58.6)	33 (8.5)	9 (90.0)	.044
Score < 20	23 (38.3)	12 (41.4)	8 (19.5)	1 (10.0)	
Diskus					
Score ≥ 20	62 (63.3)	32 (59.3)	50 (86.2)	7 (87.5)	.002
Score < 20	36 (36.7)	22 (40.7)	8 (13.8)	1 (12.5)	
Solution spray					
Score ≥ 20	8 (88.9)	65 (57)	8 (10.0)	36 (92.3)	
Score < 20	1 (11.1)	49 (43)	0 (0)	3 (7.7)	
Turbuhaler					
Score ≥ 20	42 (64.6)	60 (56.1)	57 (87.7)	14 (82.4)	.002
Score < 20	23 (35.4)	47 (43.9)	8 (12.3)	3 (17.6)	

Values are number (%).

* Visit 1 vs visit 4 for 0–1 error.

† For physician vs patient evaluation: visit 1: Aerolizer $P = .77$, Diskus $P = .67$, Turbuhaler $P = .41$; visit 4: Aerolizer $P = .09$, Diskus $P = .67$, Turbuhaler $P = .69$. No comparison was made for spray because of the small number of patients in some of the cells.

‡ Score = Asthma Control Status score

to the lungs is believed to depend primarily on correctly performed inhalation maneuvers,[9] with negative outcomes of incorrect use most pronounced among patients with poor inspiration maneuvers.[14,15] Hence, the errors in inhalation maneuvers we observed in our patients emphasizes the consequent substantial reduction in the delivery and effectiveness of the medication.[16]

However, despite the risk of insufficient drug delivery that may lead to inadequate asthma control, incorrect inhaler use has been seriously underestimated by healthcare professionals.[9] All clinicians should know proper inhaler techniques and responsibility to teach every asthma patient or refer the patient to an available education resource in the community who has proven skills in patient instruction.[16]

Given the fact that proper asthma/inhaler education should be the norm rather than the exception, we emphasize that, while the primary responsibility for patient education rests with the prescribing clinician and the dispensing pharmacist, the entire healthcare team has a role and responsibility to assure that the patient is capable of effective self-management.[16]

Published studies from around the world suggest inadequate patient education on inhaler use in 25% of patients, with rushed and poor quality education in others, without reinforcement, with almost always less than 10 min duration, and with no follow-up assessment or continuing education in most cases.[9] Notably, although the majority of our patients reported that they had learned inhaler technique from a specialist physician (for all the inhaler types), and the frequency of training by specialist physicians increased during the study, more than one third of our patients reported that their inhaler technique was not checked by a trainer.

Our finding strongly correlates with the consistently reported finding that patients' inhaler technique can be im-

Table 6. Past Inhaler Technique Training and Arbitrary Dose-Adjustment by Patients

	Solution Spray		Diskus		Turbuhaler		Aerolizer	
	Visit 1	Visit 4	Visit 1	Visit 4	Visit 1	Visit 4	Visit 1	Visit 4
Learned inhaler technique from								
Family physician	9 (4.5)	3 (3.3)	6 (3.4)	2 (2.9)	3 (1.6)	0 (0)	3 (3.0)	0 (0)
Specialist physician	133 (66.8)	79 (87.8)	125 (71.4)	61 (88.4)	139 (74.7)	79 (87.8)	70 (69.3)	51 (96.2)
Nurse, physiotherapist or technician	12 (6.0)	0 (0)	7 (4.0)	1 (1.4)	11 (5.9)	4 (4.4)	7 (6.9)	0 (0)
Nobody	3 (1.5)	0 (0)	1 (0.6)	0 (0)	1 (0.5)	1 (1.1)	1 (1.0)	0 (0)
Pharmacist	27 (13.6)	8 (8.9)	23 (13.1)	4 (5.8)	20 (10.8)	3 (3.3)	10 (9.9)	1 (1.9)
Relative/friend	7 (3.5)	0 (0)	7 (4.0)	1 (1.4)	2 (1.1)	0 (0)	5 (5.0)	0 (0)
Information brochure	8 (4.0)	0 (0)	6 (3.4)	0 (0)	10 (5.4)	3 (3.3)	5 (5.0)	1 (1.9)
Learned inhaler technique via								
Practical application	140 (82.4)	77 (93.9)	120 (81.6)	63 (95.5)	123 (74.1)	80 (97.6)	66 (77.6)	48 (94.1)
Theoretical explanation	30 (17.6)	5 (6.1)	27 (18.4)	3 (4.5)	43 (25.9)	2 (2.4)	19 (22.4)	3 (5.9)
Trainer checked the correctness of technique								
Yes, a few times	78 (45.9)	65 (79.3)	0 (0)	0 (0)	46 (27.7)	68 (82.9)	29 (33.3)	41 (80.4)
Yes, only once	36 (21.2)	13 (15.9)	105 (70.0)	61 (93.8)	48 (28.9)	12 (14.6)	26 (29.9)	8 (15.7)
No	56 (32.9)	4 (4.9)	45 (30.0)	4 (6.2)	72 (43.4)	2 (2.4)	32 (36.8)	2 (3.9)
Satisfied with the relief provided by the inhaler	92 (95.8)	43 (100)	138 (93.2)	66 (100)	156 (92.3)	80 (96.4)	81 (94.2)	47 (92.2)

Values are number (%).

proved by education from a health professional or other person trained in correct technique, and that the amount of instruction on inhaler technique given by healthcare professionals influences the likelihood of correct performance.[10,17] Also, training improves efficient use of inhaler therapy only if the training sessions are repeated and the patient's technique is checked at regular intervals.[9]

Notably, 31–85% of health professionals have been reported to show incorrect inhaler technique when tested objectively, with similar results for doctors, nurses, and community pharmacists.[18] Hence, health professionals, especially prescribing clinicians and dispensing pharmacists, who have the primary responsibility for patient education, should also make sure their own knowledge of inhaler technique is up to date.[18]

Given the increase in asthma control rate with a decrease in basic errors (to the range of 0–1) in patients, with all the inhalers, patient training on inhaler technique seems to be essential to improving the asthma control rate. Moreover, the likelihood of basic inhaler errors by most asthma patients emphasizes the importance of evaluation of inhaler technique with all inhaler types, and with all patients. Inhalers with feedback mechanisms that guide the patient through the correct inhalation maneuver would be ideal for improving inhaler technique and asthma management.[9]

Also, the compatibility of the questionnaire responses we obtained from our patients and the physicians, in terms of the role of correct inhaler technique in asthma control, seems to indicate that our Ease of Use for the Inhaler Device Questionnaire is worth further study and validation.

Conclusions

The Asthma Inhaler Treatment study found an improved asthma control rate during follow-up in adult outpatients with persistent asthma, from 61.5% to 87.0% after 6 months, regardless of patient demographics, smoking, education, or employment.[19] The findings we present here indicate higher efficacy with fixed-dose drug-combination inhalers, in achievement of asthma control and patient adherence to asthma inhaler device treatment. The basic errors in inhalation technique consisted mainly of errors during the inhalation maneuver, and the number of basic errors decreased to the range of 0–1, which was associated with better asthma control, regardless of the inhaler type. There was a concordance between the questionnaire responses from the patients and physician in terms of correct inhaler technique only for the spray type inhaler. In this regard, it is important to provide data on the efficacy of monitoring medication adherence and inhaler technique because both factors contribute to clinical efficacy and disease control. Our findings emphasize the crucial role of regular assessment and reinforcement of correct inhalation technique by the entire healthcare team, particularly the prescribing provider and dispensing pharmacist. These clinicians have primary responsibility for patient education. However, all front-line clinical providers must regularly refresh and update their own knowledge and skills, to assure they are teaching proper techniques for all inhaled delivery systems.

ACKNOWLEDGMENTS

We thank KAPPA Consultancy Training Research, Istanbul, Turkey, for editorial support; Monitor CRO, Istanbul, Turkey, for help with statistical analysis; and Aysegul Kahraman, Chiesi Pharmaceuticals, Istanbul, Turkey, for her great efforts and contributions at all stages of the study.

REFERENCES

1. Rabe KF, Adachi M, Lai CK, Soriano JB, Vermeire PA, Weiss KB, Weiss ST. Worldwide severity and control of asthma in children and adults: the global asthma insights and reality surveys. J Allergy Clin Immunol 2004;114(1):40-47.
2. Sekerel BE, Gemicioglu B, Soriano JB. Asthma insights and reality in Turkey (AIRET) study. Respir Med 2006;100(10):1850-1854.
3. Turktas H, Mungan D, Uysal MA, Oguzulgen K; Turkish Asthma Control Survey Study Group. Determinants of asthma control in tertiary level in Turkey: a cross-sectional multicenter survey. J Asthma 2010;47(5):557-562.
4. Lundback B, Dahl R. Assessment of asthma control and its impact on optimal treatment strategy. Allergy 2007;62(6):611-619.
5. Global Initiative on Asthma, National Institutes of Health, National Heart Lung and Blood Institute, NHLBI/WHO Workshop Report. Global strategy for asthma management and prevention. NHLBI/WHO workshop report no. 02-3659, January 1995, updated 2008.
6. National Asthma Education and Prevention Program. Expert Panel Report 3 (EPR-3): guidelines for the diagnosis and management of asthma-summary report 2007. J Allergy Clin Immunol 2007;120(5 Suppl):S94-S138. Erratum in: J Allergy Clin Immunol 2008;121:1330.
7. Ohta K, Yamaguchi M, Akiyama K, Adachi M, Ichinose M, Takahashi K, et al. Japanese guideline for adult asthma. Allergol Int 2011;60(2):115-145.
8. Moller M, Fritsche D, Rivera D, Libertus H. Improvement of asthma therapy by a novel budesonide multidose dry powder inhaler. Drug Res 2003;53(8):562-567.
9. 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. Respir Med 2008;102(4):593-604.
10. National Asthma Council Australia. Inhaler technique in adults with asthma or COPD. 2008. http://www.nationalasthma.org.au/uploads/content/237-Inhaler_technique_in_adults_with_asthma_or_COPD.pdf. *Accessed on November 26, 2013.*
11. Nathan RA, Sorkness CA, Kosinski M, Schatz M, Li JT, Marcus P, et al. Development of the asthma control test: a survey for assessing asthma control. J Allergy Clin Immunol 2004;113(1):59-65.
12. MAPI Research Institute: Linguistic validation. Lyon: MAPI Research Institute; 2004.
13. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. 2011 update. http://www.ginasthma.org/documents/4. *Accessed November 26, 2013.*
14. Giraud V, Roche N. Misuse of corticosteroid metered-dose inhaler is associated with decreased asthma stability. Eur Respir J 2002;19(2):246-251.
15. Rau JL. Practical problems with aerosol therapy in COPD. Respir Care 2006;51(2):158-172.
16. Fink JB, Rubin BK. Problems with inhaler use: a call for improved clinician and patient education. Respir Care 2005;50(10):1360-1374.
17. Sestini P, Cappiello V, Aliani M, Martucci P, Sena A, Vaghi A, et al; Associazione Italiana Pneumologi Ospedalieri Educational Group. Prescription bias and factors associated with improper use of inhalers. J Aerosol Med 2006;19(2):127-136.
18. Basheti IA, Armour CL, Bosnic-Anticevich SZ, Reddel HK. Evaluation of a novel educational strategy, including inhaler based reminder labels, to improve asthma inhaler technique. Patient Educ Couns 2008;72(1):26-33.
19. Yildiz F, ASIT Study Group. Factors influencing asthma control: results of a real-life prospective observational study. J Asthma Allergy 2013;6:93-101.