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Assessment of the factors affecting the failure to use inhaler devices before and after training

Yusuf Aydemir*

Sakarya University, Department of Pulmonology, Sakarya, Turkey

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KEYWORDS
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Patient education

Summary
Background: Inhaler devices used for the treatment of chronic respiratory diseases are frequently incorrectly used by the patients. The effects of training on the correct use of these devices are unquestionable. However, despite the training provided on the correct technique of using the inhaler device, some patients still continue using the device incorrectly. The aims of the present study are to determine the rate of incorrect use of the inhaler devices, assess the parameters that affect the incorrect use, demonstrate the contribution of training, and determine the characteristics of the patients who use the devices incorrectly despite training.
Methods: 342 consecutive patients were included in the study. The patients' ability to use the devices correctly was scored before and after face-to-face trainings. The parameters affecting incorrect use, the impact of training, and characteristics of the patients who continued the incorrect usage after training were evaluated.
Results: The rate of correct usage was 58.9% for dry powder inhalers (DPI) and 31.1% for pressurized metered dose inhalers (pMDI) before the training. The parameters affecting correct usage were educational status, gender, living in rural areas, duration of disease, and being diagnosed and followed-up by a chest diseases specialist. The rate of correct usage increased to 92.6% for DPI and 45.2% for pMDI after the training. The factors affecting continued incorrect usage after standard training were old age and the type of the pMDI device.
Conclusions: The technique for using the inhaler device should be described to the patients in a face-to-face session by the prescribing physician. Device selection should be done on a "trial" basis and it should be considered that particularly older patients and those using pMDIs continue using the devices incorrectly despite training; hence, alternative treatment options should be reviewed for these patients.

* Sakarya University, Training and Research Hospital, 54100 Sakarya, Turkey. Tel.: +90 5056369494.
E-mail address: dryaydemir@yahoo.com.

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Introduction

It is a well-known fact that the inhaler devices that are used for the treatment of chronic respiratory diseases are frequently incorrectly used by the patients [1—3]. The effects of training on the ability to correctly use the inhaler devices is similarly indisputable. However, despite being trained on the correct technique of using their inhaler devices, some patients still continue using their device incorrectly [4]. This prevents the disease control, negatively affects the patient's confidence in their medication, and results in a waste of resources [5].

There are a number of studies assessing the factors that affect the incorrect use of inhaler devices; however, to our knowledge, no study has been performed thus far to evaluate the characteristics of the patients who use the medications incorrectly even after standard training. The purpose of this study is to determine the characteristics of the patients who use the devices incorrectly despite training, and ensure such patients are enrolled in retraining programs or considered as candidates to receive the treatment options other than the inhaler devices.

Method

The study was designed as a real life, cross-sectional study and no intervention was done except for the standard face-to-face training sessions conducted by the same trainer.

Three hundred forty-two consecutive patients with no communication problems, who had been referred to the chest diseases polyclinics of a state hospital in the center of a metropolis (Konya, TURKEY), and have been using an inhaler device for at least one month, were enrolled in the study. Patients were surveyed using a questionnaire including questions on age, gender, level of education, place of residence, diagnosis, the physician prescribing and describing the medication, frequency of hospitalizations, and their satisfaction with the medication.

Afterwards, the patients were asked to administer medication using their own inhaler device and the inhalation procedure was observed. The main treatment devices were evaluated (quick-relief inhalers not included). Inhalation ability was assessed based on the Turkish version of the "A Guide to Aerosol Delivery Devices for Respiratory Therapists" [6] published by the American Association of Respiratory Care (AARC) and the inhalation ability chart prepared by the inhalation therapies workgroup of Turkish Respiratory Society [7]. Since the number of inhalation procedure steps was different for each device, three common statuses were defined to facilitate statistical analyses: correct use (CU), incorrect use (IU) and inadequate (false) use (FU).

IU is use in which the active substance never reaches the lung parenchyma. (complete error, no therapeutic effect). FU is use in which the active substance so as to partially reach the lung parenchyma (partial error, have therapeutic effects, but not at the desired level) (Table 1) [1]. When the observer indicated IU, the active ingredient was slightly or never inhaled to the bronchial mucosa. Weak inhalation was labeled FU, in which the active ingredient was partially inhaled into the lungs.

The same investigator then described the correct use of the inhaler device to the patients during face-to-face applied training sessions. Training sessions lasted for at least 3 min and inhaler device setup and inhalation technique were described using demonstration devices. Brochures or video demonstrations were not used. The inhalation technique was observed immediately after the training.

All patients were called for control after one month and patients were reassessed regarding the use of their own devices.

All observation and trainings were performed by a single investigator who is a chest diseases specialist.

The SPSS 21 program was used for statistical analyses. The chi square test was used for categorical assessments and linear multivariate regression analyses were performed to evaluate the correlations between variables. Statistical significance was established as $p < 0.05$.

Findings

Three hundred forty-two patients, aged between 15 and 84 years, were included in the study. Demographic data and characteristics are shown in Table 2.

Of the enrolled patients, 86.8% used a dry powder inhaler (DPI) and 13.2% used a pressurized metered dose inhaler (pMDI). Sixty-seven point three percent of the patients reported that they benefited from the device, 18.1% reported partial benefits, and 12.9% reported no benefits. Sixty-nine percent were satisfied with the medication, 19.3% were partially satisfied, and 11.4% were not satisfied. Eight point three percent of the patients believed that the medication caused addiction.

Pre-training findings

Only 55.3% of all patients were able to correctly use the devices before training. Eighty-four (24.6%) patients were completely incorrectly using (IU) the medication in a manner in which no active ingredient could be inhaled into the lungs. Among the patients using DPI, the rate of correct use was 58.9%, false was 20.2%, and incorrect use was 20.9%. There was no significant difference between the dry powder inhaler device types with respect to the rate of correct use ($p = 0.321$). Only 31.1% of the patients correctly used the pMDI. Among the pMDI users, rate of false was 20% and incorrect use was 48.9%. There was a significant difference between dry powder inhaler group and pMDI group ($p < 0.001$) (Fig. 1). The rate of correct use was significantly different with respect to the diagnosing physician and describing person, and the patients who were diagnosed and trained by a chest diseases specialist were using their medication in a more correct manner ($p < 0.001$) (Figs. 2 and 3).

Before training, the factors affecting correct use were found to be the level of education, gender, area of residence, duration of disease, being followed-up by a chest diseases specialist, and frequency of hospitalizations. The rate of correct use significantly increased as the level of education increased ($p < 0.01$). Correct use was significantly more common among men than women ($p = 0.026$),

Table 1 Definition of errors.

Incorrect use (IU), complet error
Metered dose inhalers (pMDI):
Failure to remove the cap
Not holding the inhaler upright (if the drug does not come out of the mouthpiece)
Actuation not corresponding to inhalation; actuation before inhalation
Actuation not corresponding to inhalation; actuation is too late
Failure to actuate
Failure to inhale
Inhalation through the nose
Turbuhaler:
Failure to remove cap
Dose not prepared correctly e twisting the base until it clicks
Dose not prepared correctly e turning it back to the original position
Blowing into the device before inhalation
Inhalation is not forceful from the start
Inhalation through the nose
Failure of the patient to know when the device is empty
Diskus:
Failure to slide cover and slide lever fully to open mouthpiece
Blowing into the device before inhalation
Inhalation is not forceful from the start
Inhalation through the nose
Failure of the patient to know when the device is empty
Single Dose Dry Powder Inhaler (DPI):
Failure to remove cap
Failure to insert the capsule
Failure to pierce the capsule
Blowing into the device before inhalation
Inhalation is not forceful from the start
Inhalation through the nose
Easyhaler:
Failure to remove cap
Failure to actuate
Inhalation is holding the inhaler upside down.
Blowing into the device before inhalation
Inhalation is not forceful from the start
Inhalation through the nose
False Use (FU), Partial error
Failure to shaking before actuation (for pMDI)
Failure to breathing out before inhalation
Stopping inhaling prematurely (not inhaling to TLC)
Slow and not forceful inhalation
Failure to hold breath (<3 s)
Do not control whether some powder drug rests into the capsule after inhalation (for single dose DPI)
Failure to mouth rinse after inhalation

among the patients living in the city than in those living in rural areas ($p = 0.03$), among those with a longer duration of disease than those who had been recently diagnosed ($p = 0.01$), among those being followed-up by a chest diseases specialist than those who are not ($p < 0.001$), and among those who had been frequently hospitalized than those who had not ($p < 0.001$) (Table 3).

When compared correlation between the patient satisfaction (satisfied, partially satisfied, and not satisfied) and the usage skills of inhaler device (CU, FU, and IU), respectively, significant correlation was observed. ($r = 0.614$, $p < 0.001$).

Post-training findings

After the training, the rate of correct use increased to 83.7%. For DPI, the rate increased from 58.9% to 92.6%, and for pMDI it increased from 31.1% to 45.2%. The effect of training on correct use was not different between dry powder devices. Training resulted in a substantial increase of correct use among the patients using pMDI; however the error rate was still high. After the training, the rate of FU was 45.2% and the rate of IU was 9.7% (Fig. 4). After the reassessment, one setup and one inhalation error for Diskus, one setup error for Turbuhaler, one holding inhalation

Table 2 General characteristics of study populations.

General characteristics	n	%
Age (mean) ± SD	58.26 ± 13.79 min15/max84	
Female/male	218/124	63.7/36.3
Asthma/COPD	221/121	64.6/35.4
Smoking	45	13.2
Education		
No education	74	21.6
Literate	46	13.5
Primary school	162	47.4
Middle school	23	6.7
High school	24	7.0
University	13	3.8
Living area		
Urban center	227	66.4
Rural	114	33.6
Age of disease		
<3 months	26	7.6
3 months–1 year	54	15.8
1–3 years	56	16.4
>3 years	206	60.2
Diagnosed by		
Chest diseases specialist	282	82.5
Internal medicine specialist	60	17.5
Trained by		
Chest diseases specialist	207	60.5
Internal medicine specialist	39	11.4
Trained in the pharmacy	58	17.0
Self	38	11.1
Chest diseases specialist follow-up		
None	75	21.9
Annual	225	65.8
Three times or more per year	42	12.3
Frequency of hospitalization		
None	263	76.9
Once per year	71	20.8
More than once per year	8	2.3
Drug type		
Diskus	131	38.3
Single Dose Dry Powder Inhaler	97	28.4
Turbuhaler	45	13.2
Easyhaler	24	7.0
pMDI	45	13.2

pMDI: pressurized metered dose inhaler.

error for Single Dose Dry Powder Inhaler and three inhalation error for pMDI was observed.

After the training, the significant effects of the level of education, gender, duration of disease, and frequency of hospitalization disappeared (Table 2). After the training, a significant effect of age was observed.

The association of the effects of training with various parameters

Gender

There was a significant difference between male and female patients before the training and more men were using the devices correctly ($p = 0.028$). However, this difference disappeared after the training and no significant difference was noted with respect to gender.

Age

There was no difference before the training, however, a significant difference was noted after the training and older patients were observed to continue incorrect use despite training ($p < 0.001$).

Level of education

There was a significant difference before the training ($p < 0.001$); however this difference disappeared after the training. Before the training, the rate of incorrect use was higher among the patients with no education or those who were literate; however, after the training, the rate of incorrect use was high only among the patients with no education.

Area of residence

Before the training, patients living in cities were more correctly using the devices. No significant difference was noted between the patients living in the cities and rural areas after the training.

The type of the disease

There was no significant difference before and after the training between the patients diagnosed with asthma or COPD.

Duration of disease

Before the training, patients with a longer disease duration were using their devices in a more correct manner and the difference was significant ($p = 0.011$). This difference disappeared after training.

Frequency of hospitalizations

Before the training, patients with a higher frequency of hospitalizations were using their devices in a more correct manner and the difference was significant ($p < 0.001$). This difference disappeared after training.

Diagnosing and describing person

Before the training, patients diagnosed and trained by a chest diseases specialist were using their devices in a more correct manner and the difference was significant. This difference disappeared after training.

Type of the device

A significant difference was noted before and after the training.

Discussion

Particularly in countries where the number of patients per physician is relatively high, incorrect or false use is very common among the patients since they are not given sufficient training, if any, on the use of inhaler devices [1–9].

The rate of incorrect use is higher for pMDI devices, since they require more patient coordination and cognitive function. In several wide-scale studies, the rate of

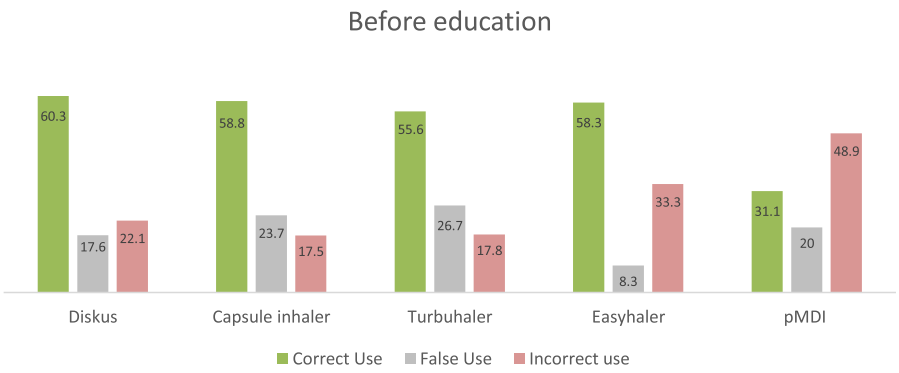

Figure 1 Ability to use the device before training (%).

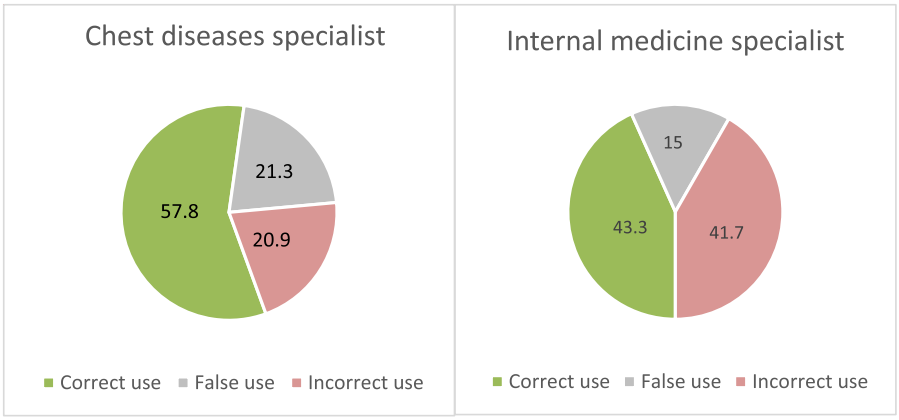

Figure 2 Inhalation ability according to the diagnosing physician (%).

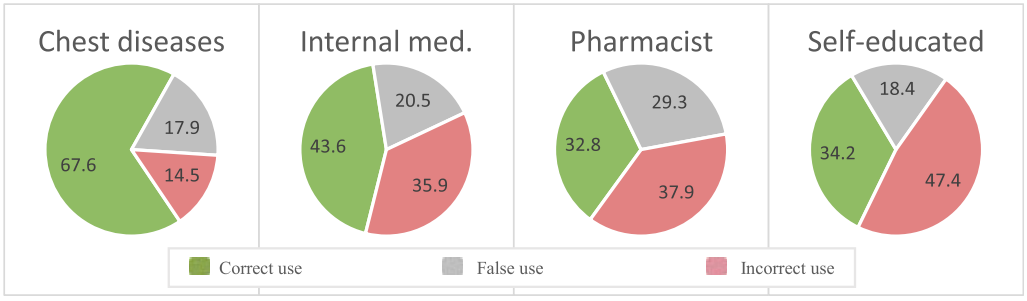

Figure 3 Inhalation ability according to the describing individual (%).

incorrect use has been reported to be 32—96% for pMDIs [10,11]. The most common errors are failing to inhale during spraying and failing to hold the breath [11,12]. In the present study, the rate of incorrect-false pMDI use was 68.9%.

Studies performed with DPI devices reported the rate of incorrect use as 10—55% [3,10—13]. In the present study, we did not observe a superiority between the DPI devices with respect to the rate of correct use before and after training, and the rate of incorrect-false use for DPIs was 41.1% before the training.

Studies evaluating the parameters that affect the incorrect use of inhaler devices have reported different results. There are studies demonstrating that age and gender has no impact on the ability to use the devices [4,14,15]. Whereas, there are studies showing that the success declines with aging [12,13,16—18], and women [18] or men [19,20], are more successful. Similarly, the level of education seems to be a factor affecting ability [17,18], whereas its effect has been reported to be insignificant in some studies [13—16]. The impact of the type of disease, asthma or COPD, has also been explored and no significant difference was shown [13,14,16]. In the present study, the factors affecting success before training were the level of education, male gender, and living in the city, while no association was found between the correct use and age or the type of the disease.

The level of education was an effective parameter before the training. Incorrect use was significantly more

Table 3 The effects of various parameters on the correct use of inhaler devices.

	Before education							After education						
	Correct Use		Incorrect Use		False Use		P value	Correct Use		Incorrect Use		False Use		P value
	n	%	n	%	n	%		n	%	n	%	n	%	
According to the level of education														
No education	22	**29.7**	36	**48.6**	16	**21.6**	*<0.001*	38	**73.1**	5	**9.6**	9	**17.3**	*0.328*
Literate	25	**54.3**	10	**21.7**	11	**23.9**		20	**90.9**	–	–	2	**9.1**	
Primary school	92	**56.8**	33	**20.4**	37	**22.8**		61	**88.4**	1	**1.4**	7	**10.1**	
Middle school	19	**82.6**	2	**8.7**	2	**8.7**		4	**100**	–	–	–	–	
High school	21	**87.5**	–	–	3	**12.5**		2	**66.7**	–	–	1	**33.3**	
University	10	**76.9**	3	**23.1**	–	–		3	**100**	–	–	–	–	
Age (mean/median)	**58**/57		**60**/64		**58**/56		*0.147*	**57**/57		**76**/78		**68**/70		*<0.001*
According to gender														
Male	80	**64.5**	21	**16.9**	24	**18.5**	*0.028*	35	**77.8**	1	**2.2**	9	**20.0**	*0.159*
Female	109	**50**	63	**28.9**	45	**21.1**		93	**86.1**	5	**4.6**	10	**9.3**	
According to disease														
Asthma	113	**51.1**	63	**28.5**	45	**20.4**	*0.052*	95	**88.0**	4	**3.7**	9	**8.3**	*0.055*
COPD	76	**62.8**	21	**17.4**	24	**19.8**		33	**73.3**	2	**4.4**	10	**22.2**	
According to the area of residence														
Urban center	133	**58.6**	46	**20.3**	48	**21.1**	*0.034*	84	**88.4**	4	**4.2**	7	**7.4**	*0.053*
Rural	56	**48.7**	38	**33**	21	**18.3**		44	**75.9**	2	**3.4**	12	**20.7**	
According to the duration of disease														
<1 year	30	**42.3**	29	**40.8**	12	**16.9**	*0.011*	36	**83.7**	3	**7.0**	4	**9.3**	*0.054*
1–3 year	35	**56.5**	13	**21**	14	**22.6**		23	**92**	2	**8**	–	–	
>3 year	124	**59.3**	42	**20.1**	43	**20.6**		69	**81.2**	1	**1.2**	15	**17.6**	
According to chest diseases specialist follow-up														
None	29	**38.7**	32	**42.7**	14	**18.7**	*0.001*	32	**69.6**	2	**4.3**	12	**26.1**	*0.011*
1 per year	134	**59.6**	46	**20.4**	45	**20**		19	**87.8**	4	**4.4**	7	**7.8**	
>1 per year	26	**61.9**	6	**14.3**	10	**23.8**		17	**100**	–	–	–	–	
According to the frequency of hospitalizations														
None	122	**46.4**	80	**30.4**	61	**23.2**	*<0.001*	118	**83.1**	6	**4.2**	18	**12.7**	*0.724*
>1 per year	67	**84.8**	4	**5.1**	8	**10.1**		10	**90.9**	–	–	1	**9.1**	
According to the type of device														
DPI	175	**58.9**	62	**20.9**	60	**20.2**	*<0.001*	113	**92.6**	4	**3.3**	5	**4.1**	*<0.001*
pMDI	14	**31.1**	22	**48.9**	9	**20.0**		14	**45.2**	3	**9.7**	14	**45.2**	

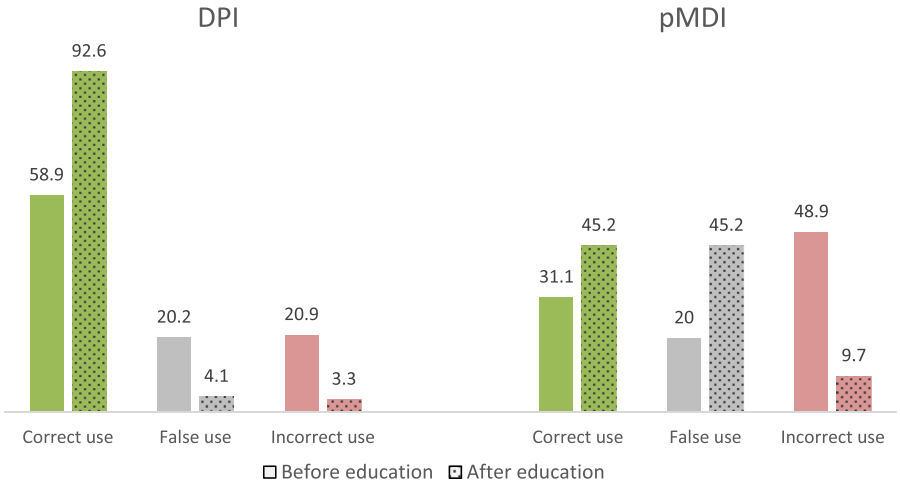

Figure 4 The effect of training on the ability to use the inhaler devices. Abbreviations: DPI: dry powder inhalation devices; pMDI: metered dose inhalation devices.

common in the group with no education. Such an increase may be associated with the fact that the literate patients or those who were at least primary school graduates can read the medication prospectus or brochure. The significant effect of the level of education disappeared after training. Five of the six patients who demonstrated incorrect use after the training were from the group with no education. This might be explained by the effect of age. The mean age of these patients was 77.4 years. Age had no significant effect on the correct use of the device before the training; however, age was a significant parameter after the training ($p < 0.001$). Patients with vision or hearing limitations were not enrolled in the study; however, the decline in perception and cognitive function with age could have contributed to these results.

Before the training, the ability to use the device was better among men. This might be related to the sociocultural structure of the region where the study was performed. It might be expected for women to have a lower rate of success in a population involving women who are rather limited to the house, are not employed, and do not have social interactions due to ethnic and religious reasons. Since the study was performed on a conservative population, the rate of success was lower in women, but the difference disappeared after training.

In the present study, we observed that the rate of correct use is very low among patients who have been trained by pharmacists. This finding suggests that pharmacists and pharmacy technicians are under informed on this subject. Such results are not surprising in countries where there is no training and certification program, particularly for pharmacy technicians.

The technique of using the inhaler device must be described to the patients. The patients learning the technique via the prospectus or brochure have a very low rate of success [16,18,21,22]. It is very important for correct use that such training is given by the prescribing chest diseases specialist rather than the nurse or family physician. Several studies performed on the healthcare professionals showed that the ability to use the inhaler devices is very low in nurses, family physicians, pharmacists-pharmacy technicians and interns, and some studies suggested that the rate of misuse among these professionals are even higher than the rate in patients [21,23—28].

Studies assessing the preference of the patients showed that the patients prefer face to face trainings given by the prescribing physicians rather than the brochures, videos, or trainings provided by the nurses and face-to-face applied trainings were found to be more successful than the other methods [14,15,21].

In this study, 69% of the patients were satisfied with the medication. This ratio seems consistent, when 20% of patients who had partial benefits in the false group are added to the 55% ratio of correct use. As high as 79% of the patients did not know whether the inhaler device was addictive or not, which is significant, as it indicates a lack of training, which is the main objective of this study. Even a part of the patients using their medication correctly were unaware of this matter. Treatment compliance may be increased by including information on the side effects and addiction to the training program on the device.

Training has an indisputable effect on the correct use of medication. In this study, we demonstrated the significant effect of training for all device types, irrespective of the level of education. However, we have observed that the effect of training was lower in the pMDI group and some patients continued to make partial errors even after the training.

When the characteristics of the patients who continued incorrect use after training were reviewed, only the age and the type of the device had a significant effect.

These results show that the physicians should pay attention, in particular, while prescribing pMDIs to elderly patients. Such patients' ability to use the device should be observed after the training, and the physicians should consider DPIs or home-nebulizer devices if inhalation cannot be achieved with the correct technique [29].

One of the limitations of this study is the lack of an assessment of the relation between the ability to use inhaler devices and the severity of the disease. Studies including comparisons of pulmonary function test parameters, asthma control tests, and COPD severity degree might be helpful. Another limitation is the lack of re-assessment at six months and one year time intervals after the training. The change in the success rates in time was not evaluated.

In conclusion, it must be the chest diseases specialists' duty and responsibility to teach the patients the correct inhalation technique of the inhaler devices. Applied, face-to-face trainings must be provided by the prescribing physician and the device selection should be done on a "trial" basis together with the patients. Polyclinics should involve training areas with the necessary documentation and visuals that may be provided to the patients, and the trainings should be repeated at regular intervals. Inhaler device training nurses should be designated at the chest diseases clinics and training should be provided and administration should be observed for every hospitalized patient. Manufacturing companies should increase the trainings given to the pharmacists/pharmacy technicians and provide them with the necessary visuals and brochures. This subject should be included in the training schedule of the health faculties and in-service trainings should be given to the professionals. Finally, media support should be used to increase the awareness of chronic airway diseases and treatment in the community.

Author disclosure statement

YA has no conflicts of interest.

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