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Inhaler devices in asthma and COPD — An assessment of inhaler technique and patient preferences

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Summary
Background: Incorrect use of inhaler devices remains an obstacle for respiratory diseases management. We aimed to evaluate the frequency of inhaler technique errors; to determine the devices perceived as the easiest and favourite to use; to study the association of device type, demographics and patient preferences with inhaler technique (IT).
Methods: Cross-sectional assessment of 301 adults, with asthma (194) or chronic pulmonary obstructive disease, undergoing treatment with Aerolizer®, Autohaler®, Breezehaler®, Diskus®, Handihaler®, MDI without spacer, Miat-haler®, Novolizer®, Respimat® and/or Turbohaler®. Patients completed self-assessment questionnaires and face-to-face interview, with demonstration of inhaler technique. The rate of wrong steps (number of wrong steps ÷ number of total steps; RWS) was the primary outcome. Adjusted odds ratio (aOR) (95% confidence intervals [CI]) for presenting ≥1 IT errors were computed.
Results: From the 464 inhaler technique performances, the median RWS was 18%. Turbohaler® (21%) and Diskus® (19%) were chosen as easiest and Novolizer® (18%), Diskus® (18%), Turbohaler® (17%) as favourite for daily use. Females (aOR 2.68 [95% CI 1.55–4.65]; vs. males], patients with >64 yr (aOR 2.73 [95% CI 1.15–6.48]; vs <45 yr) and patients using Aerolizer® or Handihaler® (aOR 3.24 [95% CI 1.13–9.32] and aOR 3.71 [95% CI 1.38–10.2], respectively) were more likely to perform IT errors; otherwise, no association was found, including with using the favourite device (aOR 1.43 [95% CI 0.84–2.42]).

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Conclusion: The frequency of inhaler technique errors was high and no device was clearly preferred over the others. Using the preferred inhaler device was not associated with less errors.

Introduction

Inhaled therapy is the cornerstone in the management of asthma and chronic obstructive pulmonary disease (COPD). There are two main groups of inhaler devices: metered dose inhalers (MDI) and dry powder inhalers (DPI). Many devices have been developed and each has specificities on how to prepare the dose and deliver the drug to the airways. Although different devices have technological improvements to airway drug delivery, important limitations remain [1]. In fact, decades after the introduction of inhaler devices, their incorrect use remains an obstacle to achieve optimal disease outcomes [2].

The correct use of inhaler devices is one of the most important aspects to be taken into account when evaluating individuals with asthma or COPD, and guidelines [3,4] emphasize the importance of assessing inhaler technique to improve the efficiency of drug delivery. Furthermore, it is recognized that inadequate use of inhaler devices is one of the most common reasons for failure to achieve asthma control [3]. A recent review reports a high percentage of inhaler technique errors, but with great variability among studies [5]. Moreover, the perceived complexity of inhaled therapy may lead to treatment withdrawal, further impairing the achievement of disease control. In fact, Santus et al. [6] found that 18% of patients stopped inhaled therapy spontaneously, mainly due to the complexity of treatment, despite a reported suitable medical explanation.

To understand how to improve the use of inhalers, different aspects have been studied, such as types of devices [2,7—10]; patient factors (age, gender, education) [2,9,11,12]; and patient preferences. [8,13] Yet, research results regarding the interaction between patient, device and technique are insufficient and inconsistent.

The aims of this study are: 1) to evaluate the frequency of errors in the inhaler technique of asthma and COPD patients; 2) to determine which inhaler device is perceived as the easiest and which is considered the favourite for daily use; 3) to study the association of device type, demographic characteristics and patient preference variables with inhaler technique.

Material and methods

Study design and participants

This was a cross-sectional observational study, carried out in the Allergology and Pneumology outpatient clinics of the Centro Hospitalar São João, a tertiary university hospital in Porto, Portugal, from April to August 2013. Adult patients attending the outpatient clinics were invited to participate and were included if they had a medical diagnosis of asthma or COPD and were currently using an inhaler device. In this study, we assessed the most commonly used devices from those available in Portugal: Aerolizer®, Autohaler®, Breezehaler®, Diskus®, Handihaler®, MDI without spacer, Miat-haler®, Novolizer®, Respimat® and Turbohaler®. Patients using different inhaler devices or those who were unable to read and/or write were excluded.

This study was conducted according to the principles of the Helsinki Declaration. Written informed consent was obtained from all participants. The study procedures were approved by the Ethics Committee of Centro Hospitalar São João. We have followed STROBE recommendations for reporting observational studies [14].

Instruments and data collection

Data were collected using a structured written questionnaire (filled autonomously by the patient) and a face-to-face interview.

First, the participant answered a questionnaire which evaluated the self-perception on his/her inhaler technique ("I perform correctly the technique of my inhaler"), satisfaction with the inhaler device, including comfort with public use ("I feel satisfied with my inhaler" and "I feel comfortable using my inhaler in public") and the perception on how his/her preferences were taken into account at the time of inhaler's prescription ("I feel that my physician took into account my opinion and preferences when choosing my inhaler"). These questions were answered using Visual Analogic Scales (VAS), ranging from 0 (worst) to 100 (best) millimetres.

Immediately after, without any additional training, each participant was asked to show the interviewer how he/she usually used the inhalers currently prescribed, using placebo devices. The inhaler technique for each device was evaluated through observation using checklists based on the manufacturers' instructions available in the Portuguese drug agency database [15]. Summarized lists of the recommended inhaler steps for each device are presented in Supplementary Tables 1—3. The interviewer registered if each step was performed properly and in an adequate order.

After the assessment of inhaler technique, the interviewer explained the adequate inhaler technique for the participant's device(s) and demonstrated how to use the remainder inhalers. After the explanation and demonstration of use, each participant had the opportunity to test the available inhalers by him/herself.

Finally, each participant was asked to elect the device perceived as the easiest and the one they would prefer for daily use; the reason(s) underlying the choice of the inhaler for daily use were inquired through an open question.

The study questionnaire was pre-tested in 12 patients in order to check for readability and ease of understanding. To ensure uniformity of the assessment, all interviews were performed by the same trained interviewer. In order to reduce possible confounding related to differences in the therapeutic effect of inhaled drugs available for each device, it was explicitly stated, during the interview, that all questions were related only to the physical and functional aspects of the inhalers and not to the drug and/or its effects or safety.

Statistical analysis

The main outcome of this study was the rate of wrong steps (RWS), defined as number of inhaler technique wrong steps divided by the total number of recommended steps. We calculated the sample size based on the RWS. Considering a significance level of 0.05, we admitted a standard deviation for the RWS of 0.15, with a margin of error of 0.014. The sample size calculated for these parameters was 444 demonstrations of inhaler technique. Considering the same standard deviation of 0.15 for the RWS of each inhaler device, the inclusion of 40 demonstrations per device gives this study a power of 85% to detect a difference of 0.1 between the RWS of two different inhalers.

Categorical variables were described using absolute frequencies and proportions with 95% confidence intervals (95% CI); comparisons were performed using the Pearson chi-square test. For statistical analysis, age was recoded in three groups (<45; 45 to 64; and >64 years old) and the level of education was categorized according to the Portuguese education system (1–4; 5–9; 10–12; and >12 years of school education). Continuous variables were described using mean with standard deviation (SD) or median with interquartile range, as appropriate to the data distribution; comparisons were performed using non-parametric Mann–Whitney *U* and Kruskall–Wallis tests, as adequate. The inhalers used by less than 5% of total patients were not analysed individually except in what refers to the patient's preferences. The associations between the RWS and both VAS score and duration of inhaler use were studied with Spearman correlation coefficients (r^2). The level of significance was set at $p < 0.05$.

Univariate logistic regression models were developed using independent variables as risk factors for "presence of errors in the inhaler technique". The univariate models considered all the available factors with a possible association with the inhaler technique, including patient characteristics (medical diagnosis, gender, age and school education), device features (type of device, time of use and number of different devices in use) and patient preferences regarding the devices that are considered the easiest and the favourite for daily use. Multivariate logistic regression models were developed for the presence of errors in the inhaler technique. The factors with a *p*-value <0.250 in the univariate analysis were included in the initial multivariate model; the model was progressively adjusted considering its calibration (Hosmer–Lemeshow statistics), discriminative power (Area Under the Curve from the Receiver Operating Curve) and the adjusted *p*-value of each variable; a $p > 0.05$ in the Hosmer–Lemeshow statistics was deemed necessary to consider that the model was calibrated. The final model included gender, age groups, years of school education and type of inhaler device; interactions (2 × 2) between different variables were tested but did not significantly improve the model and were not included. Results of both univariate and multivariate logistic regression models were presented as odds ratio (OR) with [95% confidence interval (95% CI)]. Statistical analysis was conducted using SPSS Statistics® version 21 for Windows (IBM SPSS, Chicago, IL, USA).

Results

Overall, 464 devices were being used by the 301 individuals included in the study. All the participants completed the study questionnaire and there was no missing data regarding individual questions.

The characteristics of the participants and their currently used inhalers are presented in Tables 1 and 2, respectively. Turbohaler® and Diskus® were the most widely used devices, accounting for 27% and 19%, respectively, of all inhalers; Autohaler®, Breezehaler®, Miathaler®, Novolizer® and Respimat® represented less than 5% of the devices in current use. Individuals with asthma used more frequently Turbohaler® (corresponding to 34% of total inhalers used in asthma), while most patients with COPD reported to use Handihaler® and Diskus® (26% and 21% of total COPD devices, respectively). Duration of use was, on average, similar between devices (mean [±SD] 4–5 (±4–5) years) except for MDI, which had been in use for a longer period [9 (±10) years]. High grades were reported in the self-evaluation of inhaler technique (median 94%, p25–p75 74–94%) and satisfaction with the current device (median 87%, p25–p75 74–94%). Table 2 summarizes these results to

Table 1 Participants diagnosis, demographics and number of different inhalers used ($n = 301$).

	All 301	
	n	%
Diagnosis		
Asthma	194	64
COPD	107	36
Gender (females)	181	60
Age (mean, SD)	53	17
<45	90	30
45–64	132	44
>64	79	26
School years		
1–4	138	46
5–9	67	22
10–12	62	21
>12	34	11
Number of current different inhalers		
1	166	55
2	108	36
≥3	27	9

Table 2 Devices used, perception of correct technique and satisfaction with current inhaler ($n = 464$).

Devices ($n = 464$)	Frequency of use		Self-evaluation of correct technique[a]		Satisfaction with current device[a]	
	n	%	P50	(P25—P75)	P50	(P25—P75)
Turbohaler	128	27	86	(74—97)	79	(74—97)
Diskus	90	19	95	(74—97)	90	(74—97)
Handihaler	77	17	96	(75—97)	93	(74—97)
Aerolizer	64	14	96	(75—97)	93	(75—97)
MDI	54	12	92	(74—97)	92	(74—97)
Respimat	18	4	97	(76—97)	95	(74—98)
Novolizer	12	3	78	(74—97)	74	(50—94)
Breezehaler	11	2	96	(85—98)	96	(78—97)
Miat-haler	8	2	59	(12—97)	62	(8—75)
Autohaler	2	<1	62	(49—74)	50	(49—50)

[a] Visual analogic scale, range 0—100 (best).

each device. The scores regarding patient's perceived involvement in the choice of the device(s) and public use of the inhalers were also high (median 75%, p25—p75 26—96% and median 86%, p25—p75 48—97%, respectively).

Fig. 1 shows the percentage of flawless inhaler technique performances and the distribution of the RWS for the most widely used inhaler devices. The frequency of errors at each recommended step, discriminated by device, is presented in the Supplementary Tables 1—3 available online.

When considering the preference on the easiest inhaler device, 56% of patients chose their current inhaler, 10% chose devices used in the past and 34% elected an inhaler they had never used. When considering the favourite device for daily use, 40% of participants chose their current device, 9% a device used in the past and most (51%) preferred a device they had never used. Fig. 2 shows the proportion of patients reporting each device as the preferred (considering both the easiest and the favourite for daily use). Table 3 describes the reasons underlying the choice of an inhaler for daily use. Physical characteristics of the device were the most frequently reported motives for choosing an inhaler as the favourite (Table 3); characteristics such as the colour control window present in Novolizer® (which provides feedback to the patient) and the compact format of Breezehaler® were referred, respectively, by 70% and 48% of the participants who selected Novolizer® and Breezehaler®, as the most important reasons for their choices.

Duration of use ($p = 0.253$), perception of correct technique performance ($p = 0.106$), satisfaction with the device ($p = 0.376$), patient involvement by the physician ($p = 0.947$) and comfort with the use of the device in public ($p = 0.607$) did not significantly correlate with the RWS.

Females (vs. males, $p < 0.001$), older individuals (>64 vs. ≤64 years old; $p < 0.001$) and those with lower level of education (1—4 years vs. >12 years; $p = 0.001$) had a higher RWS. The diagnosis of asthma or COPD ($p = 0.643$), the number of different inhalers used ($p = 0.067$), currently using the device chosen as the easiest to use ($p = 0.292$) and currently using the favourite device ($p = 0.092$) had no statistically significant association with the RWS.

Table 4 presents the odds ratio with 95% CI for inhaler technique with errors, based on the univariate and multivariate logistic regression analysis. Individuals who where not using their favourite device had no significant increase

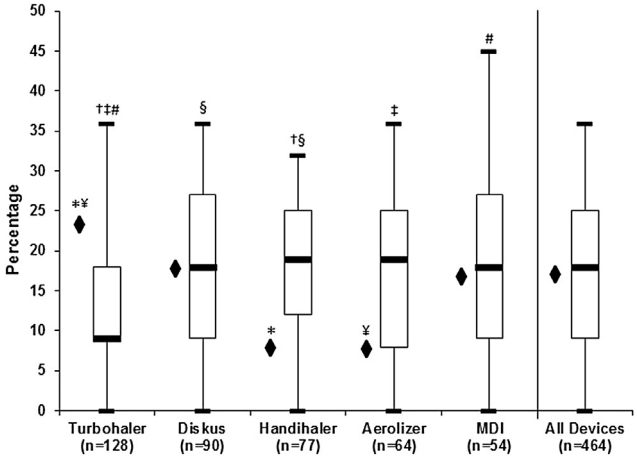

Figure 1 Percentage of participants with flawless inhaler technique performances (diamonds) and distribution of rate of wrong steps (boxes and whiskers). Footnote: Percentage of users with flawless inhaler technique performances is represented by the diamond symbol. Distribution of the rate of wrong steps (number of wrong steps ÷ total number of steps; RWS) for the more frequently used devices. Box represents 25—75 percentiles and rectangle box the median. Whiskers represent 5 and 95 percentiles. Pearson chi-square test was used to test for statistical significant differences in the percentage of flawless inhaler technique executions and Mann—Whittney *U* test was performed to test for statistically significant differences in the RWS. * $p = 0.006$ for Turbohaler vs Handihaler. ¥ $p = 0.011$ for Turbohaler vs Aerolizer. † $p = 0.001$ for Turbohaler vs Handihaler. ‡ $p = 0.020$ for Turbohaler vs Aerolizer. # $p = 0.015$ for Turbohaler vs MDI. § $p = 0.038$ for Diskus vs Handihaler.

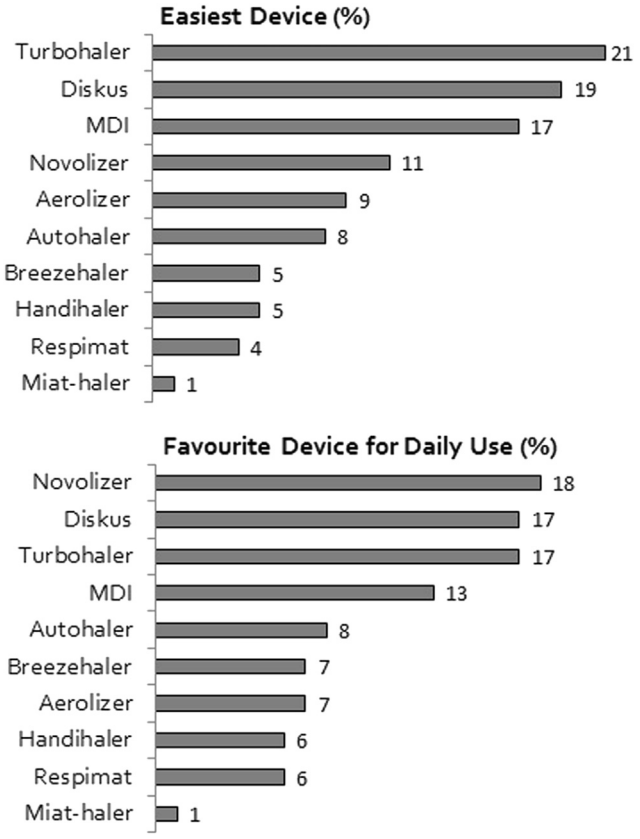

Figure 2 Percentage of patients reporting each device as the preferred, considering the easiest (left panel) and the favourite for daily use (right panel) devices, $n = 301$ patient.

in the OR for the presence of at least one error in the inhalation technique (crude OR 1.43 [95% CI 0.84—2.42]; vs. already using the favourite device).

Discussion

In this cross-sectional observational study we observed a high RWS in inhaler technique and a corresponding low percentage of inhaler technique performances without errors. In multivariate analysis, females, elder patients and those using the Aerolizer® and Handihaler® devices had higher odds of performing errors. Other variables such as inhaler device factors (e.g.: using more than one type of device), medical diagnosis, education and patient preferences, including using the preferred inhaler device, were not associated with correct inhaler technique. Finally, there was no consensus on the inhaler device to be considered as the 'easiest' or as the 'preferred for daily use'.

Our study design takes a pragmatic approach to inhaler technique assessment in asthma and COPD patients that is applicable to routine clinical care. Inhaler technique was assessed through observation of patient's demonstration by face-to-face interview, and we used checklists based on the manufactures' instructions. As participants inclusion criteria were broad and based on the medical diagnosis of asthma or COPD, they had a fairly diverse experience with inhaled therapy. Furthermore, we comprehensively assessed factors that have previously been described separately, such as the type of inhaler device, disease, demographic characteristics and patient preferences. We included a set of 10 different inhaler devices, which is, to our knowledge, the largest to be simultaneously assessed in a study. Patient preferences have not been previously studied in such a comprehensive scenario.

Nevertheless, this study has some limitations that should be considered. We could not compare all devices regarding the RWS, because some devices (Autohaler®, Breezehaler®, Miat-haler®, Novolizer®, Respimat®) were used infrequently. During the interviews we felt patients often had difficulties in separating previous experiences with medications from the devices that were used to deliver them, although it was explicitly said by the interviewer that only the physical and functional aspects of the device were being evaluated. Also, some participants might have not fully understood the VAS questions. Moreover, under or over reporting of inhaler technique errors due to interviewer bias can not be excluded, although using a single interviewer prevented inter-observer variability. We recognise that evaluating some steps, especially the rapid and forceful inhalation needed to correctly use a DPI, only through observation is subjective, but it simulates a real life setting, where most decisions are clinically based and the equipment to accurately measure the inspiratory flow is seldom available. Also, we did not questioned the patients about the type of training on inhalation technique they had previously or about how long ago they had that training and who ministered it. Thus, we cannot assess the influence of past training in the performances observed. Likewise, the cross-sectional design limits the interpretation of the findings and influence of duration of use on the frequency and dynamics of technique errors. Additionally, this study was conducted in a single healthcare institution and we cannot exclude a selection bias; furthermore, illiterate individuals were excluded. This may limit the generalization of our results to other populations.

A critical limitation to all studies evaluating inhaler technique is the lack of consensus regarding the methodology to assess and value errors. Other studies used several different methods such as critical errors [2], essential steps [7,9,10], grading systems [8] or error cut-offs [11—13,16]. We calculated a rate of wrong steps, without valuing any particular steps. This method may overestimate the prevalence of incorrect use of inhaler devices, since it considers all steps recommended by manufacturers as a potential source of error, but it reduces the subjectivity of grading the relevance of some errors over others in the absence of solid knowledge on the importance of each error on the distribution of the drug into the airways.

Inhaler technique assessment detected a high RWS across many of inhaler technique stages, which corresponded to low proportion of performances without mistakes. In previous studies, Turbohaler® was reported as having more technique errors than MDI, Handihaler®, Aerolizer® and Diskus® [2,17] but surprisingly we observed that Turbohaler® surpassed the performance of MDI and the single-dose DPI devices, while Diskus® was only statistically different from Handihaler®. Despite this result, no inhaler device had an overall technique performance that was superior to all the others.

Table 3 Motives stated by participants for choosing a device as favourite for daily use, sorted by preference for daily use (see Fig. 2).

	Accustomed to 18%		Easy 26%		Practical 26%		Physic characterist. 30%	
	n	%	*n*	%	*n*	%	*n*	%
Novolizer	1	1	5	8	6	9	54	82
Diskus	14	21	19	29	25	38	8	12
Turbohaler	27	44	9	14	15	24	11	18
MDI	9	21	18	41	14	31	3	7
Autohaler	1	4	18	67	6	22	2	7
Breezehaler	2	7	6	21	5	17	16	55
Aerolizer	5	23	9	41	6	27	2	9
Handihaler	5	26	4	21	7	37	3	16
Respimat	2	10	4	21	7	37	6	32
Miat-haler							2	100

The reasons stated by the participants were grouped according to its general type: 'Practical' includes 'practical' and 'fast to use'; 'Physic characterist.' includes 'colour control window' (only for Novolizer), 'small size', 'hygienic', 'dosage counter', 'design' and 'discretion'.

Previous reports suggest that inhaler device mishandling worsens the clinical outcome [2,16,18], and therefore our data is motive of concern. Despite the differences in the inhalation technique, the choice of the inhaler device should be based on a physician-patient agreement, considering patient preferences, skills, availability of the intended drug, cost and physician experience [1,3,4]. An educational project on inhaler technique directed both to healthcare professionals and patients reported improved outcomes in asthma and COPD patients [19], underlining the role the effectiveness of educational interventions. Other interventions suggest that education should be provided in a continuous [13] and interactive fashion [18]. Furthermore, evidence suggests that if the inhaler technique is performed correctly, similar outcomes can be achieved regardless of the type of inhaler device used by the patient [20].

All inhaler devices included in this study had similar average durations of use, with the exception of MDI that had been used for a longer period of time. It has been suggested that the duration of inhaler use may be associated with the presence of errors in inhaler technique. However, in accordance with the results reported by Hashmi et al., [11] we did not observe such relationship. Likewise, our results are in agreement with previous literature reporting that there is no difference in the performance of inhaler technique according to the number of inhaler devices in use [2,9]. However, some authors reported more misuse amongst patients with multiple types of devices [7,10,12].

A previous study by Melani et al. [2] reported no statistically significant differences in inhaler technique between asthma and COPD patients, after adjusting for inhaler device, age and level of instruction. Our data support this lack of association. Nevertheless, they are discrepant with the results from Khassawneh et al.; [7] in that study there is a report of higher odds of incorrect inhaler technique in COPD patients, after adjusting for age, gender and level of education, although the authors attribute the difference to older age and the presence of more comorbidities in COPD patients.

When considering demographic variables, we observed a higher odds ratio of poor inhaler technique in the elderly, as observed in previous studies [2,9]. Moreover, our data suggests that females, when compared to males, present a greater odds of having incorrect inhaler technique. However, in what refers to gender, most of the published studies reported no differences in inhaler technique [2,9,11,12]. This disagreement may be due to methodological differences, such as restricted analysis to specific errors [2,9] or application of cut-offs to define correct technique [11,12]. Nevertheless, it seems that female patients often have worse asthma control in spite of higher inhaled corticosteroid use [21] and COPD females seem to have more limitation, more dyspnoea and higher consumption of respiratory medication [22]. Furthermore, anxiety and depression are known to affect symptoms. Women with asthma have higher anxiety levels and female asthma patients with anxiety consume more asthma medication [23], and, in COPD, anxiety and depression are related to dyspnoea, although equally prevalent in males and females [24]. Still, inhaler technique may contribute to the different outcomes observed between genders and should be addressed in future studies.

An inverse relation between years of school education and incorrect inhaler technique was previously reported [2,11]. We observed a similar trend in multivariate logistic regression analysis, with individuals with 5–9 years of school education presenting the highest OR for incorrect technique; however, individuals with higher level of school education were not significantly different from those with 1–4 years of education. Fayas et al. [12] observed that knowledge on asthma and inhaler technique, but not the level of academic education, was associated with better inhalation techniques; in our study, no specific data on asthma knowledge was collected. Nevertheless, recently, the WHO Regional Office for Europe suggested school education as one of the many factors that influences health

Table 4 Odds ratio (OR) from univariate (crude) and multivariate (adjusted) logistic regression analysis for the presence of at least one error in the inhaler technique.

	Crude OR (95% CI)	Adjusted OR (95% CI)
Diagnosis		
Asthma	1.02 (0.62–1.66)	
COPD	Reference	NI
Gender		
Male	Reference	Reference
Female	2.01 (1.23–3.29)	2.68 (1.55–4.65)
Age groups (years)		
<45	Reference	Reference
45–64	2.18 (1.23–3.86)	2.29 (1.11–4.75)
>64	2.13 (1.12–4.06)	2.73 (1.15–6.48)
School years		
1–4	Reference	Reference
5–9	1.80 (0.86–3.76)	3.11 (1.31–7.37)
10–12	0.75 (0.40–1.40)	1.27 (0.57–2.86)
>12	0.58 (0.28–1.21)	0.87 (0.36–2.09)
Number of different devices		
1	Reference	NI
>1	1.80 (1.10–2.94)	
Inhaler device		
Aerolizer	3.46 (1.27–9.42)	3.24 (1.13–9.32)
Diskus	1.36 (0.69–2.68)	1.51 (0.73–3.11)
Handihaler	3.47 (1.37–8.79)	3.71 (1.38–10.02)
MDI	1.47 (0.64–3.35)	1.07 (0.45–2.57)
Other	0.86 (0.40–1.82)	0.97 (0.43–2.18)
Turbohaler	Reference	Reference
Time of inhaler use (years)		
<1	Reference	NI
1 to 5	1.36 (0.73–2.53)	
>5	1.28 (0.65–2.53)	
Already using the easiest device		
Yes	Reference	NI
No	1.26 (0.77–2.08)	
Already using the favourite device		
Yes	Reference	NI
No	1.43 (0.84–2.42)	

NI – Not included.

literacy [25]; this WHO manuscript did not include data from Portugal. Still, our observation seems to imply that physicians should not fully rely on the level of education as a predictor of correctness of inhalation technique.

Guidelines recommend considering patient's opinions and preferences regarding their inhaler device(s) and technique(s) when assessing inhalation technique [3]. Press et al. [18] reported that patients over-estimate their inhaler technique. Our analysis supports these findings, since most patients were confident about the correctness of their inhaler technique performance and this self-perception was not significantly associated with a lower RWS. Additionally, we observed that higher satisfaction with the inhaler device, personal perspective of being engaged by the physician in the choice of the device and feeling comfortable to use inhaler devices in public had no significant influence on the performance of inhaler technique.

To study patient preferences, we compared ten inhaler devices to determine which was considered the easiest and the preferred for routine use but we could not identify an inhaler clearly favoured over the others. Interestingly, however, preferences seem to be greatly influenced by the prescription experience of our patients, since 66% chose the easiest device and 49% the preferred for routine use among those currently or formerly used.

When considering the motive(s) for choosing an inhaler device as the preferred for routine use, we observed that reasons and their relative representation varied across each device. This opposes a previous report on patient preferences that referred that ease of use was the leading reason underlying the patient's choice; nevertheless that study was not designed to assess motives [8]. The widely distributed preferences relating inhaler devices along with the existence of diverging reasons for the choice, indicates that prescription should not be standardized and that each patient must be considered individually.

Lenney et al. [8] previously reported that prescribing the preferred device to the patient might improve inhaler technique. In that study, the authors recruited patients referred for inhaler assessment and evaluated inhaler technique for all the devices immediately after giving verbal instruction and demonstrating their use. In our study, data does not support an association between using the preferred inhaler device and the correctness of inhaler technique. However, we invited participants with different backgrounds of inhaler use from an outpatient clinic and inhaler technique was assessed prior to any demonstration from the interviewer, which represents a more reliable approach to a real-life clinical setting.

In conclusion, incorrect inhaler technique is frequent, especially in older patients, female patients and those using single-dose DPIs. No inhaler device had a significant lower rate of wrong steps or was clearly preferred by the majority of the patients. Our data suggests that prescribing the patient's preferred inhaler is not associated with a better inhalation technique.

Conflict of interests

Pedro Chorão and Ana Pereira have no conflicts of interest to declare.

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Appendix A. Supplementary data

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References

[1] Virchow JC, Crompton GK, Dal Negro R, Pedersen S, Magnan A, Seidenberg J, et al. Importance of inhaler devices in the management of airway disease. Respir Med 2008;102(1):10—9.

[2] Melani AS, Bonavia M, Cilenti V, Cinti C, Lodi M, Martucci P, et al. Inhaler mishandling remains common in real life and is associated with reduced disease control. Respir Med 2011;105:930—8.

[3] Global Strategy for Asthma Management and Prevention. Global initiative for asthma (gina). Available at: http://www.ginasthma.org/; 2012 [accessed October 2013].

[4] Global Strategy for the Diagnosis Management and Prevention of COPD. Global initiative for chronic obstructive lung disease (gold). Available at: http://www.goldcopd.org/; 2014 [accessed February 2014].

[5] Sanchis J, Corrigan C, Levy ML, Viejo JL. Inhaler devices - from theory to practice. Respir Med 2013;107:495—502.

[6] Santus P, Picciolo S, Proietto A, Falcone F, Mangiacavallo A, Pellegrino G, et al. Doctor-patient relationship: a resource to improve respiratory diseases management. Eur J Int Med 2012;23:442—6.

[7] Khassawneh BY, Al-Ali MK, Alzoubi KH, Batarseh MZ, Al-Safi SA, Sharara AM, et al. Handling of inhaler devices in actual pulmonary practice: metered-dose inhaler versus dry powder inhalers. Respir Care 2008;53:324—8.

[8] Lenney J, Innes JA, Crompton GK. Inappropriate inhaler use: assessment of use and patient preference of seven inhalation devices. Respir Med 2000;94:496—500.

[9] Wieshammer S, Dreyhaupt J. Dry powder inhalers: which factors determine the frequency of handling errors? Respiration 2008;75:18—25.

[10] van der Palen J, Klein JJ, van Herwaarden CL, Zielhuis GA, Seydel ER. Multiple inhalers confuse asthma patients. Eur Respir J 1999;14:1034—7.

[11] Hashmi A, Soomro JA, Memon A, Soomro TK. Incorrect inhaler technique compromising quality of life of asthmatic patients. J Med 2012;13:16—21.

[12] Fayas S, Estivals M, Gontier B, Têtu L, Rafalimanana G, Didier A. Facteurs déterminants la qualité de la prise des traitements inhalés dans l'asthme. Rev Fr Allergol Immunol Clin 2003;43:364—8.

[13] Ronmark E, Jogi R, Lindqvist A, Haugen T, Meren M, Loit HM, et al. Correct use of three powder inhalers: comparison between diskus, turbuhaler, and easyhaler. J Asthma 2005;42:173—8.

[14] Vandenbroucke JP, von Elm E, Altman DG, Gotzsche PC, Mulrow CD, Pocock SJ, et al. Strengthening the reporting of observational studies in epidemiology (strobe): explanation and elaboration. PLoS Med 2007;4:e297.

[15] Infarmed — Autoridade Nacional do Medicamento e Produtos de Saúde I.P, Infomed — drugs for human use database, Available at: http://www.infarmed.pt/infomed/inicio.php [accessed February 2013]

[16] Giraud V, Roche N. Misuse of corticosteroid metered-dose inhaler is associated with decreased asthma stability. Eur Respir J 2002;19:246—51.

[17] Molimard M, Raherison C, Lignot S, Depont F, Abouelfath A, Moore N. Assessment of handling of inhaler devices in real life: an observational study in 3811 patients in primary care. J Aerosol Med 2003;16:249—54.

[18] Press VG, Arora VM, Shah LM, Lewis SL, Charbeneau J, Naureckas ET, et al. Teaching the use of respiratory inhalers to hospitalized patients with asthma or copd: a randomized trial. J Gen Intern Med 2012;27:1317—25.

[19] The Cambridge Consortium. Evaluation of inhaler technique improvement project. Available at: http://wessexhiecpartnership.org.uk/wires/knowledge-resources/inhaler-technique-the-inhaler-technique-improvement-project/; 2012 [accessed February 2014].

[20] Dolovich MB, Ahrens RC, Hess DR, Anderson P, Dhand R, Rau JL, et al. Device selection and outcomes of aerosol therapy: evidence-based guidelines: American college of chest physicians/American college of asthma, allergy, and immunology. Chest 2005;127:335—71.

[21] Temprano J, Mannino DM. The effect of sex on asthma control from the national asthma survey. J Allergy Clin Immunol 2009;123:854—60.

[22] Lopez Varela MV, Montes de Oca M, Halbert RJ, Muino A, Perez-Padilla R, Talamo C, et al. Sex-related differences in COPD in five Latin American cities: the Platino study. Eur Respir J 2010;36:1034—41.

[23] Fernandes L, Fonseca J, Martins S, Delgado L, Pereira AC, Vaz M, et al. Association of anxiety with asthma: subjective and objective outcome measures. Psychosomatics 2010;51:39—46.

[24] Carreiro A, Santos J, Rodrigues F. Impact of comorbidities in pulmonary rehabilitation outcomes in patients with chronic obstructive pulmonary disease. Rev Port Pneumol 2013;19:106—13.

[25] Kickbusch I, Pelikan JM, Apfel F, Tsouros AD. Health literacy — the solid facts. World Health Organization Regional Office for Europe; 2013. Available at: http://www.euro.who.int [accessed December 2013].