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ORIGINAL ARTICLE

Most frequent errors in inhalation technique of patients with asthma treated at a tertiary care hospital

Erros mais frequentes na técnica inalatória de pacientes com asma brônquica em tratamento em hospital terciário

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ABSTRACT

Objective: To demonstrate the most frequent errors in inhalation technique in patients with asthma undergoing treatment at a tertiary care hospital. **Methods:** A cross-sectional study with a convenience sample of asthma patients aged 18 years or over, treated at a pulmonology outpatient clinic of a tertiary care hospital. The assessment of inhalation technique of users of the dry powder inhalers Aerolizer®, Aerocaps and Diskus®, or metered-dose inhalers was based on the manufacturer's instructions for use of each inhaler device. Patients demonstrated the inhalation technique with empty inhaler devices, and it was considered correct when all stages were performed properly, or when errors probably did not interfere with the treatment outcome. **Results:** Among 71 participants, 43 (60.5%) performed inhalation technique incorrectly. Among metered-dose inhalers and dry powder inhalers users, inhalation technique errors were found in 84.2% and 51.9%, respectively (p=0.013). Errors were more frequent at the exhalation stage (67.4%), followed by breathing in (58.1%) and apnea (51.2%). In the group using dry powder inhalers, the most common errors occurred during exhalation and, for those using metered-dose inhalers, the most compromised stage was aspiration. **Conclusion:** Errors were more frequent among those using metered-dose inhalers compared with dry powder inhalers. Misconceptions are more common at the expiration stage among users of dry powder inhalers and in aspiration among those on metered-dose inhalers.

Keywords: Asthma; Asthma/therapy; Inhalation; Nebulizers and vaporizers/utilization

RESUMO

Objetivo: Demonstrar os erros mais frequentes na técnica inalatória de pacientes com asma brônquica em tratamento em hospital terciário. **Métodos:** Estudo transversal, com amostra de conveniência de pacientes com asma, com 18 anos ou mais, em tratamento em ambulatório de pneumologia de um hospital terciário. A avaliação da técnica inalatória dos usuários dos dispositivos de pó seco Aerolizer®, Aerocaps® ou Diskus®, ou de aerossóis dosimetrados teve como base as orientações da bula do fabricante de cada dispositivo inalatório. Os pacientes demonstraram a técnica inalatória com dispositivos inalatórios vazios, e ela foi considerada correta quando todas as etapas foram realizadas de forma apropriada, ou quando os equívocos provavelmente não interferiam no resultado do tratamento. **Resultados:** Entre os 71 participantes, 43 (60,5%) realizaram a técnica inalatória de forma incorreta. Dentre os usuários de aerossóis dosimetrados e dispositivos de pó seco, ocorreram erros de técnica inalatória em 84,2% e 51,9%, respectivamente (p=0,013). Os erros foram mais frequentes na etapa da expiração (67,4%),

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seguidos da aspiração (58,1%) e da apneia (51,2%). No grupo que usava dispositivos de pó seco, os erros mais comuns aconteceram na expiração e, nos que utilizavam aerossóis dosimetrados, a etapa mais comprometida foi a aspiração. **Conclusão:** Os erros foram mais frequentes entre os que usavam aerossóis dosimetrados em comparação com dispositivos de pó seco. Os equívocos foram mais comuns na etapa da expiração entre os usuários de dispositivos de pó seco e na aspiração entre os que usavam aerossóis dosimetrados.

Descritores: Asma; Asma/terapia; Inalação; Nebulizadores e vaporizadores/utilização

INTRODUCTION

Asthma affects about 300 million people worldwide.[1] In Brazil, in 2016, there were 1,972 deaths related to asthma – more than 5 a day.[2]

When treating asthma, drugs are administered primarily by inhalation, with rapid action, low doses and rare adverse events.[3] One of the factors related to non-control of asthma is incorrect inhalation technique.[4,5]

Not enough time to see each patient, lack of knowledge by the healthcare team about the proper stages of correct inhalation technique, and the technical language used to teach are among the reasons that often hinder the learning process of inhalation technique.[6]

The use of metered-dose inhalers (MDI) requires better motor coordination, but a previous review reported errors are also common with dry powder inhaler (DPI) devices.[7]

The types of errors vary in different studies, but the most common seem to occur during exhalation, before aspiration, followed by apnea.[8,9]

Knowledge of the most frequent errors of the inhalation technique can help in medical orientation as to the adequate use of inhaling devices, improving inhalation technique, and contributing towards control of asthma.

OBJECTIVE

To demonstrate the most frequent errors in inhalation technique of patients with asthma undergoing treatment at a tertiary care hospital.

METHODS

This is a cross-sectional study with a convenience sample, comprising patients with asthma, aged 18 years or over, under treatment at one of the pulmonology outpatient clinics of the *Hospital Universitário Antônio Pedro*, *Universidade Federal Fluminense*, in the city of Rio de Janeiro (State of Rio de Janeiro - RJ). The participants were not at their first medical visit, were not in a phase of exacerbation, and were using drugs through by a DPI (Aerolizer®, Aerocaps®, or Diskus®) or MDI, with no spacer. All patients had their inhalation techniques evaluated, and those who used a second inhalation device, different from primary device, were also evaluated as to inhalation techniques of the second inhalation device - but the data were not analyzed in this study. The clinical diagnosis of asthma was made as per the Global Initiative for Asthma (GINA).[10]

Patients with a diagnosis of asthma not confirmed at follow-up, and those who received help from third parties for the use of the inhalation device, were excluded.

After signing the Informed Consent Form provided by the *Universidade Federal Fluminense*, CAAE: 56248816.1.0000.5243, opinion no. 1.650.534, recruitment was initiated. This was done sequentially, and the questionnaire was filled in with sociodemographic data, with the investigation of previous offer of orientation as to the inhalation technique by the physician, and the time of use of the inhalation device.

Next, the inhalation technique was demonstrated with empty inhalation devices to at least two raters of the team (a pulmonologist and six medical undergraduate students trained by the pulmonologist). All patients had their inhalation techniques video-recorded for reassessment, in case of discrepancy among the raters. In case of disagreement between two raters, a third rater also evaluated the patient.

The evaluation of inhalation technique was based on the instructions for use of the manufacturing industry of each inhalation device. Its was considered correct only when all stages had been done appropriately, or when mistakes probably did not interfere in the result of treatment (not removing the capsule, not closing the mouthpiece after removing the capsule, and not closing the inhalation device at the end of the demonstration). The inhalation technique was considered wrong when one or more errors were observed in any of the following stages: assembly and preparation of the inhalation device before expiration, in exhalation, in aspiration or during apnea step, after aspiration, regardless of the severity of the error. Whenever errors were noted in the inhalation technique, the patient was oriented again.

The data obtained were input on a Microsoft Excel 2010 spreadsheet and imported for statistical analysis by the EpiInfo™ 7.2 software. For the descriptive analysis of the numeric data, central tendency (mean and median), and dispersion measures were used. Calculations of the simple and relative frequencies were

used for the questions with categorized answers. To verify the association among the categorical variables, the χ^2 or Fisher's exact tests were used, as per theoretical indication. The significance level for all tests was 0.05, that is, the associations were when significant when the p value (descriptive level) was less than 0.05.

RESULTS

Between August 2, 2016 and March 10, 2017, a total of 75 patients were included in the study. Of these, four were excluded: one for having an immobilized arm, which hindered demonstration of inhalation technique without help; one for being diagnosed as chronic obstructive pulmonary disease, and not as asthma in the continuity of treatment; and two because they used the Aerocaps® inhalation device, when they should have been on Aerolizer® to administer their medications.

The sample analyzed had 71 participants aged 19 to 81 years, with mean age of 57.7±13.9 years, and 61 (85.9%) were female. Thirty of them were white (42.2%), 15 (21.1%) were black, and 26 (36.7%), brown. Fourteen (19.7%) were single, 31 (43.7%) were married, and 26 (36.6%) were widowed, single, or divorced. As to personal income, 49 (70%) received up to one minimum salary per month, 20 (28.6%) between 1 and 3 minimum salaries, and one (1.4%) from 3 to 10 minimum salaries. The family income of 28 (40.0%) patients was up to 1 minimum wage, 38 (54.3%) received from 1 to 3 minimum wages, and 4 (5.7%), from 3 to 10 minimum wages. As to schooling, 37 (52.1%) had at most, complete Elementary School (9 years of study), 29 (40.8%) complete High School, and 5 (7.1%) had a College Education or Graduate Studies, even if incomplete.

Table 1 demonstrates the homogeneity among the groups of the study. No significant differences were found between the sociodemographic characteristics components of the groups that used DPI and metered-dose inhalers.

Forty-one (57.8%) patients were in treatment for more than 2 years at the outpatient clinic, always coordinated by the same physician specialist in pulmonology, and 53 (74.7%) had used the same inhalation device for at least 2 years. Only one (1.4%) patient reported never having received orientation as to the use of the inhalation device.

Regarding the type of inhalation device, 52 (73.3%) used DPI, 10 patients used Aerolizer®, 36 Aerocaps, Diskus, and 19 (26.7%) MDI. Forty-three (60.5%) patients performed the inhalation technique incorrectly, and errors were oberved more often during expiration

Table 1. Sociodemographic characteristics of the sample

Variable	Total n (%)	Dry powder devices n (%)	Metered-dose inhalers n (%)	p value*
Sex				0.25
Female	61 (85.9)	46 (64.8)	15 (21.2)	
Male	10 (14.1)	6 (8.4)	4 (5.6)	
Marital status				0.7
Married	31 (43.7)	22 (31.0)	9 (12.7)	
Not married	40 (56.3)	30 (42.2)	10 (14.1)	
Schooling level*				0.55
Up to 9 years	37 (52.1)	26 (36.6)	11 (15.5)	
Over 9 years	34 (40.9)	26 (36.6)	8(11.3)	
Personal income†‡				0.86
Up to 1 minimum wage	49 (70.0)	36 (51.4)	13 (18.6)	
>1 minimum wage	21 (30.0)	15 (21.4)	6 (8.6)	
Family income				0.82
Up to 1 minimum wage	28 (40.0)	20 (28.6)	8 (11.4)	
>1 minimum wage	42 (60.0)	31 (44.3)	11 (15.7)	

χ^2 test or Fisher´s exact test. * school grades complete or not; †monthly minimum wage in Brazil was U$ 264.3, on March 20, 2018; ‡ onepatient did not inform personal and family income.

(Figure 1). The frequency of errors of inhalation technique in each phase, as per the inhalation device used, can be visualized on figure 2.

Among the users of MDI and DPI, there were errors in inhalation technique in 84.2% and 51.9%, respectively (p=0.013). The most frequent errors among the users of DPI were at expiration, and among those who used MDI, the stage with most errors was aspiration. There was no statistically significant difference in errors occurring during the stages of assembly, expiration, and apnea between users of DPI and MDI. During aspiration, there were fewer errors among individuals using DPI as compared to those on MDI (Table 2).

Every type of error was noted in the use of inhalation devices. Among MDI users, not taking the lid off before use, inadequate positioning (inhalation device upside down), poor adjustment to the mouth, successively pressuring the inhalation device during aspiration, and delay at the start of aspiration after pressuring the top of the inhalation device were the errors observed. Whereas among those who used DPI, the following failures were observed: expiration performed with the inhalation device in the mouth, maintaining the keys pressured (held down) during breathing in, and not put pressure on the keys to perforate the capsule. Successive aspiration occurred among users of both devices. The most frequent errors, however, were short (7) or inexistent (19) expiration; short (10) or inexistent (10) aspiration; and short (8) or inexistent (10) apnea.

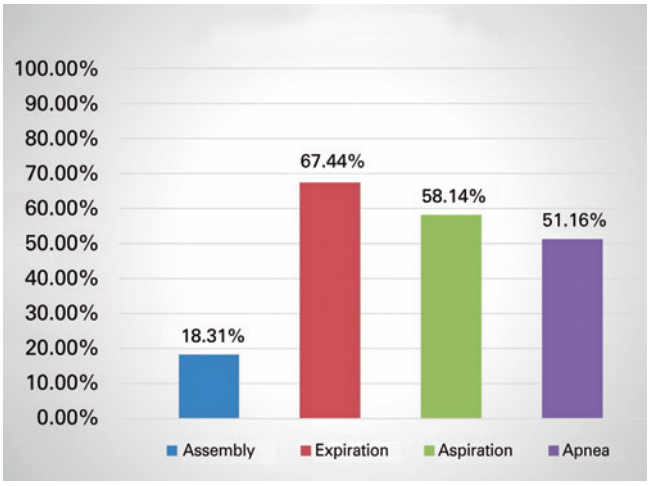
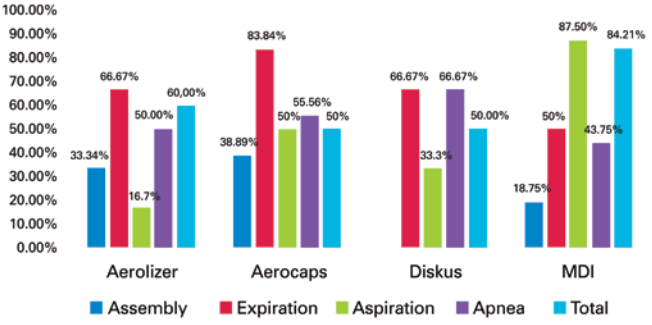


Figure 1. Frequency of errors per inhalation technique stages



MDI: metered-dose inhalers.

Figure 2. Frequency of inhalation technique errors, per stage, as per inhalation device used

Table 2. Comparison by stages of handling the inhalation device among patients who made errors in inhalation techniqueInhalation technique

	Total n (%)	Dry powder devices n (%)	Metered-dose inhalers n (%)	p value*
Correct assembly				0.3
Yes	12 (27.9)	9 (20.9)	3 (7.0)	
No	31 (72.1)	18 (41.9)	13 (30.2)	
Correct expiration				0.06
Yes	14 (32.6)	6 (14)	8 (18.6)	
No	29 (67.4)	21 (48.8)	8 (18.6)	
Correct breathe-in				0.02
Yes	18 (41.8)	16 (37.2)	2 (4.6)	
No	25 (58.2)	11 (25.6)	14 (32.6)	
Correct apnea				0.45
Yes	21 (48.8)	12 (27.9)	9 (20.9)	
No	22 (51.2)	15 (34.9)	7 (16.3)	
Correct inhalation technique†				0.013
Yes	28 (39.5)	25 (35.2)	3 (4.2)	
No	43 (60.5)	27 (38.0)	16 (22.5)	

* $\chi 2$ test or Fisher´s exact test; † complete sample (71 patients).

DISCUSSION

At this outpatient clinic, the inhalation technique is demonstrated to all patients in every visit. The physician always demonstrates it with an empty device just like that used by each patient. Invariably, the patients are requested to bring to visits their empty inhalation devices for training, and when they do, they perform the inhalation technique in front of the physician. When errors are perceived, they are always corrected. It is possible that the patient who reported never having been instructed, would only consider him/herself instructed if they brought their empty device for training, which sometimes does not happen, because part of the patients also report not remembering to do so.

Despite all care mentioned, about 60% of patients incorrectly performed the inhalation technique. These results are similar to those previously published,[11,12] although better than the ones described in other studies.[13,14] One should consider that the inhalation technique evaluation in this study was very strict. The inhalation techniques were only considered correct if there were no errors in the stages considered essential. Three participants attributed the errors made to anxiety generated by the evaluation and video-recording, which perhaps also contributed towards the high percentage of patients with an incorrect inhalation technique. One study went against this idea, raising the hypothesis that the patients can present with a more correct inhalation technique because of being observed.[9]

The assembly and preparation stages have particularities that vary according to each inhalation device. In this study and in these specific stages, the errors were less frequent than in the remaining stages, and there was no statistically significant difference between the number of errors made by DPI and MDI users. On the other hand, the stages of expiration, aspiration, and apnea, which are necessary and common to all the currently existing inhalation devices, and probably to all that will exist in the future, more than 50% of patients committed errors. Perhaps it is not a coincidence that in a prior study conducted with the participation of undergraduate medical students and physicians, the most frequent errors occurred exactly in these same three stages.[8] If the physicians do not master the correct inhalation technique, they will not teach it to their patients.

Reducing errors in these last stages mentioned is directly related to continued education and orientation of patients. We point out that almost all patients who stated using their inhalation devices correctly, when invited to demonstrate their inhalation technique to the

physician, committed at least one error.[15] Therefore, it is crucial that physicians observe patients using the inhalation device, whether with placebos, empty inhalation devices, or with the patient's own inhalation device that is still in use. This last method has the disadvantage of the patient not being able to repeat the inhalation technique several times at that visit, until the technique is adequate and without errors.

Likewise in several studies,[9,14,16,17] expiration was the stage where most errors were noted when the inhalation devices were evaluated together. A short or absent exhalation, in patients who already present impaired pulmonary function due to asthma, can have repercussions in the subsequent stages, generating an insufficient aspiration, and the impossibility of maintaining the necessary time of apnea later on. Roy et al.,[18] demonstrated that, in expiration, there were more errors among users of MDI than of DPI. In the current study, despite the fact that there were more errors observed in those using DPI as compared to MDI in this phase, such discrepancy showed no statistical difference.

The errors in the inhalation technique were more frequent with MDI than with DPI, a fact that was also demonstrated by other authors.[7,13,16,19] Among 19 MDI users, only 3 performed the inhalation technique correctly, while among those who used DPI, approximately 50% were able to execute the action without errors. The most common errors among MDI users occurred in the aspiration phase. The need to coordinate oneself precisely at the moment of putting pressure on top of MDI and starting to breathe-in seems to be an additional challenge with this inhalation device. Special attention is suggested when orienting and supervising the beginning of this stage, as had already been highlighted,[8] or, alternatively, choose to use spacers.

As to errors in the apnea stage, no statistically significant difference was noted between those using MDI or DPI. After expiration, this phase is frequently cited as the second in terms of most errors [14,18,20] in the inhalation technique. In this study, it was surpassed in errors by the aspiration stage, probably because MDI users made more mistakes in this phase.

Regarding the limitations of the study, the inhalation technique assessments were made by two or more raters, but they were not performed blindly and separately, but rather, jointly. Additionally, this is a sample from a tertiary care hospital of the Public Healthcare System, where the most frequently referred cases are those difficult to control. Supervision of the quality of inhalation technique may not occur at every visit at other centers. Thus, the results obtained may not represent the real status of these other sites, and limit generalizations.

Errors in inhalation technique are frequent regardless of the inhalation device used. The expiration stage was the most compromised in the group of inhalation devices studied. Among patients who used DPI, expiration was the stage with most errors, and among the MDI users, breathing was the most hindered phase.

Reports of patients who stated they never received orientation, or were given instructions only at the first visit, are not uncommon.[20] There are also various studies demonstrating that the majority of asthma patients, do not have the disease under control.[4,21] The objective of asthma treatment is control. There is no alternative. Quality supervision of inhalation technique should be an integral part of every medical visit. Ideally, the patient should demonstrate their inhalation technique to the doctor at each visit. The instructions must be given and repeated exhaustively. Otherwise the objective will not be reached, since quality of the medication is not important if it does not reach the airways.

CONCLUSION

More than 60% of patients committed errors in their inhalation technique. The errors are common, regardless of the inhalation device utilized. Errors were more frequents among those who used a metered-dose inhalers in comparison with those on dry powder inhaler. After compliance with treatment, the most important factor to obtain control of asthma is an adequate inhalation technique. Supervision of how patients perform the inhalation technique is fundamental, and it should be done at every visit. Special attention should be given to the expiration phase, when there is the greatest concentration of errors regardless of the inhalation device used, and to the aspiration phase in the metered dose inhaler users.

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