



Study of inhaler technique in asthma patients: differences between pediatric and adult patients

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INTRODUCTION

Inhaler technique comprises a set of procedures for drug delivery to the respiratory system. The oral inhalation of medications is the first-line treatment for lung diseases, and metered-dose inhalers (MDIs) are one of the drug delivery systems most frequently used by patients.⁽¹⁾ The use of oral medications offers many advantages, because these medications act directly on the airways and require administration of lower doses, with no gastric changes.⁽²⁾ Using the proper inhaler technique ensures sufficient deposition of drug particles in the distal airways, optimizing drug effectiveness and reducing possible side effects.

One of the determinants of the effectiveness of inhaled medications is the ability of the patient to adhere to good inhaler techniques.⁽³⁾ For some patients, that can be difficult, and the prescription of medication should therefore always be accompanied by appropriate inhaler technique training delivered by a health professional. Thus, it is possible to reduce the number of inhaler technique errors and minimize the clinical consequences of poor drug delivery.

The first therapeutic aerosol devices were developed in the 1950s⁽⁴⁾ and consisted of nebulizers and atomizers containing anticholinergics for treatment of asthma.⁽⁵⁾ Despite the long time since development and the wide use of these devices, inhaler technique errors continue to be common among respiratory patients,⁽⁶⁾ reducing the benefits of inhaled medications. In Chile, Solís

ABSTRACT

Objective: Inhaler technique comprises a set of procedures for drug delivery to the respiratory system. The oral inhalation of medications is the first-line treatment for lung diseases. Using the proper inhaler technique ensures sufficient drug deposition in the distal airways, optimizing therapeutic effects and reducing side effects. The purposes of this study were to assess inhaler technique in pediatric and adult patients with asthma; to determine the most common errors in each group of patients; and to compare the results between the two groups. **Methods:** This was a descriptive cross-sectional study. Using a ten-step protocol, we assessed inhaler technique in 135 pediatric asthma patients and 128 adult asthma patients. **Results:** The most common error among the pediatric patients was failing to execute a 10-s breath-hold after inhalation, whereas the most common error among the adult patients was failing to exhale fully before using the inhaler.

Conclusions: Pediatric asthma patients appear to perform most of the inhaler technique steps correctly. However, the same does not seem to be true for adult patients.

Keywords: Administration, inhalation; Aerosols/administration & dosage; Asthma/prevention & control.

et al.⁽⁷⁾ observed that only 12.5% of the mothers of hospitalized infants have a correct inhaler technique. However, it is unknown whether this trend is reflected in adult patients, given that the elderly are more likely to make inhaler technique errors.⁽⁸⁾ This promotes the assessment of inhaler technique by age group, because tailoring education to the needs of each patient could significantly improve disease management. The purposes of the present study were to assess inhaler technique in pediatric and adult patients with asthma; to determine the most common errors in each group of patients; and to compare the results between the two groups.

METHODS

This was a descriptive cross-sectional study conducted in the region of Valparaíso, Chile, between March and May of 2014. The sample consisted of male and female patients with a diagnosis of asthma based on spirometry, in accordance with the Global Initiative for Asthma criteria.⁽⁹⁾ The ages of the participants ranged from 5 to 90 years, and the sampling was non-probabilistic (purposive). Patients had to meet the following inclusion criteria: being enrolled in and attending follow-up visits as part of an asthma program in clinics in the region of Valparaíso, regardless of smoking status; having received a prescription for a bronchodilator and having been instructed on the proper use of their inhaler (practical demonstration by a nurse, physician, or kinesiologist at each follow-up appointment); and being able to self-administer inhaled medication. We

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excluded patients who had a respiratory comorbidity or any concomitant condition that could directly affect inhaler technique (prostration, oxygen dependence, or altered cognitive status).

All participants gave written informed consent, and the study was approved by the Research Ethics Committee of the University of Santo Tomás at Viña del Mar School of Kinesiology.

For comparative purposes, the patients were divided into two groups: pediatric patients (5-18 years); and adult patients (19-90 years). The volunteers were recruited during their follow-up appointments at the health facilities. On that occasion, they were scheduled to undergo assessment one week later. On the assessment day, they were asked to use their inhaler as usual. All volunteers used their own valve spacer (appropriate to their age). They received no additional instruction, coaching, or correction during inhaler use. The medication administered was albuterol (100 µg; Fesema®; Laboratorio ETEX, Santiago, Chile), used as rescue medication and delivered with an MDI.

Inhaler technique was assessed using a protocol described by Melani,⁽¹⁰⁾ as shown in Table 1. This protocol documents the performance of ten essential inhaler technique steps by means of closed dichotomous response options (well performed/poorly performed). All assessments were made by two investigators with ten years of experience in the follow-up of asthma patients. After assessment, all patients were given supplemental instruction on inhaler technique by a health professional, in the form of a demonstration.

On the basis of a study of inhaler technique in pediatric patients,⁽¹¹⁾ which reported an 89.1% completion rate for "hold breath for 10 seconds", we calculated that, in order to achieve an alpha of 5%, a statistical power of 80%, and an estimation error of 6%, a sample size of at least 104 patients was required. Allowing for a loss of 10%, we determined that the minimum sample size needed was 115 patients.

For data analysis, we used descriptive statistics, calculating the number of errors per patient and the percentage of completion for each step of the protocol. The results were tabulated and analyzed with Microsoft Excel 2010. Differences between the percentages of errors made by each group were determined by the equivalence test for two proportions. Values of $p < 0.05$ were considered significant.

RESULTS

The total number of patients selected was 270. We excluded seven patients, for the following reasons: prostration ($n = 2$); oxygen-dependence ($n = 2$); Alzheimer's disease ($n = 2$); and sequelae of pulmonary tuberculosis ($n = 1$). The final sample therefore consisted of 263 patients: 135 pediatric patients and 128 adult patients. Of those, 44.1% were male. All patients had been diagnosed with bronchial asthma.

Table 1. Inhaler use protocol described by Melani.⁽¹⁰⁾

1. Remove the cap from the inhaler
2. Shake the inhaler before use
3. Exhale before using the inhaler
4. Insert the inhaler into the spacer
5. Hold the inhaler upright with the mouthpiece at the bottom during use
6. Take only one puff at a time
7. Actuate the inhaler in the first half of inhalation
8. Inhale slowly while actuating the inhaler
9. Continue to inhale after actuation
10. Hold breath for 10 seconds

The general characteristics of the participants are shown in Table 2. In the pediatric group, the most well-represented age group was the 13- to 18-year group, with 63 patients, whereas the 61- to 75-year group was predominant, with 51 patients, in the adult group.

Table 3 shows the types of errors made by the pediatric and adult patients. The most common errors in the pediatric group were failing to execute a 10-s breath-hold after inhalation (in 8.1%) and failing to continue to inhale after actuation (in 6.1%). In the adult group, 53.1% failed to exhale before using the inhaler, whereas 46% failed to execute a 10-s breath-hold after inhalation.

Table 4 shows the frequency of correct and incorrect inhaler technique, by patient age group. In the 61- to 75- and 76- to 90-year age groups, the frequency of incorrect technique was greatest (48 and 35 patients, respectively). Significant differences were found in the frequency of incorrect technique between the pediatric and adult groups.

DISCUSSION

The results of the present study show that most of the pediatric patients used correct inhaler techniques. The most common errors were failing to execute a 10-s breath-hold after inhalation (in 8.1%) and failing to continue inhaling after actuation of the device (in 6.1%). Among the adult patients, the most common errors were failing to exhale before using the inhaler (in 53.1%) and failing to execute a 10-s breath-hold after inhalation (in 46%). Crompton et al.⁽¹¹⁾ stated that poor inhaler technique in older patients might be due to cognitive impairment and their inability to retain the instructions received from the medical team. It is important to point out that, although the protocol used in our study is a guide for correct inhaler technique in adult patients, we found that pediatric patients appear to have better inhaler technique.

These results are consistent with what was described by Flor et al.⁽¹²⁾ Studies of inhaler technique have established that the most common errors are, in order of incidence, as follows: poor coordination between actuation and inhalation; an insufficient breath-hold after inhalation; excessive inhalation flow; failing

Table 2. General characteristics of the sample.

Age, years	n ^a	Male gender, % ^b	Characteristic				Tobacco consumption, % ^b
			Age, years	FEV ₁ ^d	FVC ^d	FEV ₁ /FVC ^d	
Pediatric patients							
5-6	8	87.5	6.0 ± 0.5	82 ± 20	100 ± 9	72 ± 9	0.0
7-8	13	76.9	7.0 ± 0.5	81 ± 15	98 ± 8	70 ± 8	0.0
9-10	21	47.6	9.0 ± 0.5	81 ± 7	99 ± 7	70 ± 9	0.0
11-12	30	50.0	12.0 ± 0.5	79 ± 14	99 ± 10	71 ± 5	0.0
13-18	63	47.6	14.0 ± 0.5	79 ± 19	101 ± 8	72 ± 7	30.0
Adult patients							
19-30	12	58.3	23 ± 0.7	78 ± 10	101 ± 18	71 ± 8	25.0
31-45	6	50.0	34.0 ± 0.6	82 ± 9	102 ± 15	69 ± 11	33.3
46-60	25	48.0	51.0 ± 0.6	80 ± 10	99 ± 19	70 ± 7	28.0
61-75	51	49.0	67.0 ± 0.7	81 ± 12	98 ± 18	71 ± 9	29.4
76-90	34	52.9	79.0 ± 0.5	79 ± 15	95 ± 15	69 ± 9	14.7
Total	263	100.0					

^aNumber of patients in each age group. ^bProportion for each age group. ^cValues expressed as mean ± SD. ^dPercentage of predicted value.

Table 3. Frequency and percentages of inhaler technique errors observed in the pediatric and adult groups.

Type of error	Pediatric group		Adult group	
	n ^a	% ^b	n ^a	% ^b
Failing to exhale before using the inhaler	5	3.7	68	53.1
Failing to hold breath for 10 s	11	8.1*	59	46.0*
Failing to take only 1 <i>puff</i> at a time	4	3.0	37	28.0
Failing to continue to inhale after actuation of the inhaler	8	6.1	35	26.5
Failing to actuate the inhaler in the first half of inhalation	4	3.0	30	22.7
Failing to shake the inhaler before use	0	0.0	25	18.9
Failing to inhale gently and deeply while actuating the inhaler	4	3.0	14	10.6
Failing to insert the inhaler into the spacer	1	0.7	11	8.6
Failing to hold the inhaler upright with the mouthpiece at the bottom during use	0	0.0	2	1.5

^aNumber of patients who made the error. ^bProportion within each group. **p* < 0.001 (equivalence test for two proportions).

to shake the canister vigorously before use; failing to continue to inhale after actuation; pressing the canister down several times during the course of a single inhalation; exhaling during actuation; and failing to hold the inhaler upright.⁽¹³⁾

Other authors have observed that the rate of inhaler technique errors decreases when devices other than MDIs are used.⁽¹⁴⁾ However, drug delivery effectiveness is similar when inhaler technique is correct,⁽¹⁵⁾ regardless of the device used.

Poor inhaler technique has clinical consequences ranging from minor to critical.^(6,10) Under this criterion, the results of our study allow us to state that the most frequent error made by the pediatric patients (made by 13 subjects) would moderately affect drug deposition in the lung, whereas the most frequent error made by the adult patients (made by 90 subjects) would slightly affect this deposition. As for specific consequences, the poor inhaler technique observed in the two groups of patients can affect drug delivery to the distal airways and prevent drug deposition on the respiratory epithelium.⁽¹⁶⁾ The clinical implication of these results is that, in patients with poor inhaler technique, there is a waste of inhaled medication. Consequently, there

would be an increase in the economic costs associated with the disease, an increase in the risk of side effects, and a reduction in treatment effectiveness.

Respiratory patient education is a critical factor in the proper use of medications.⁽¹⁷⁾ Asthma patient education programs substantially improve adherence and inhaler technique.⁽¹⁸⁾ All participants in our investigation regularly attend their follow-up appointments, and, at each such opportunity, they are instructed in the proper use of their medications. Nevertheless, our results show that errors in inhaler use persist. These mistakes are considered either unintentional (patients not noticing that their inhaler technique is poor) or intentional (patients knowingly using the incorrect inhaler technique).⁽¹⁸⁾ In addition, there is clear evidence that inhalers are underused among asthma patients.⁽¹⁹⁾ In this aspect, one of the limitations of our study was that we did not delve into the causes of the observed errors, which would have made it possible to provide each patient with specific supplemental instruction on the proper administration of the medication.

In our sample, we found that approximately 30% of the adult patients were smokers. Although this proportion is lower than observed among adults in Chile

Table 4. Frequency of correct/incorrect inhaler technique, by age group.

Age (years)	Correct technique	Incorrect technique
Pediatric patients	n	n
5-6	5	3
7-8	12	1
9-10	14	7
11-12	19	11
13-18	49	14
%	73.4	26.6*
Adult patients		
19-30	9	3
31-45	0	6
46-60	1	24
61-75	3	48
76-90	1	35
%	9.4	90.6*

*p < 0.05 (equivalence test for two proportions).

(40.6%),⁽²⁰⁾ it is significant, given that smoking affects asthma control.⁽²¹⁾ Therefore, tobacco consumption in these patients would further increase the difficulty in controlling the disease.

Recent studies suggest that better results would be obtained by tailoring inhaler prescription to suit the characteristics and functional capabilities of each

patient.⁽²²⁾ It has been observed that even individuals with correct inhaler technique can make errors if they are reassessed over time,⁽²³⁾ which makes it mandatory to provide patients with ongoing education in the administration of inhaled medications. Many times there are factors that hinder this learning process, such as limited duration of appointments, a lack of knowledge on the part of health care personnel about the correct steps of the inhaler technique, and the technical language used in teaching the technique.⁽¹⁶⁾ Therefore, it is necessary to use new methods to provide patients with supplemental instruction on correct inhaler use, such as videos or illustrative leaflets that can promote the retention of information by patients.⁽²⁴⁾ In addition, it is necessary that supplemental instruction on inhaler use protocols be properly provided to health personnel and included in asthma clinical guidelines, which rarely address the administration of inhaled medications.⁽²⁵⁾

In conclusion, we found that most pediatric asthma patients appear to have correct inhaler technique. However, the same does not seem to be true for approximately 90% of adult patients, among whom the most common error was failing to exhale before using the inhaler. We suggest that asthma patients, especially those who are older, should be given supplemental instruction on inhaler technique through the use of new methods, so that they can administer their medications properly.

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