

Metered-dose inhaler for asthma patients: knowledge and effects of a theoretical and practical guidance for pediatricians

Uso de inaladores dosimetrados em pacientes com asma: conhecimentos e efeitos de uma orientação teórico-prática para pediatras

Fábio Pereira Muchão¹, Luiz Vicente Ribeiro Ferreira da Silva Filho¹, Antonio Carlos Pastorino¹, Joaquim Carlos Rodrigues¹

ABSTRACT

Objective: To evaluate the effect of a theoretical and practical guidance on knowledge of pediatricians regarding the use of metered dose inhalers with spacers. To identify major deficiencies, correct them and train these physicians on the correct use of the devices. **Methods:** Pediatricians who participated in a theoretical-practical program focusing on the use of inhaler devices answered a questionnaire with five questions about the use of these devices before and after the program. A comparison of the scores obtained in the pre- and post-training tests was performed by Wilcoxon test for related samples, and a significance level of 0.05 was adopted. **Results:** Twenty pediatricians performed pre- and post-training tests. The performance of pediatricians in the post-training test was significantly better than baseline ($p < 0.001$). **Conclusion:** A brief orientation program for pediatricians significantly improved their knowledge on the use of metered-dose inhalers with spacers, which may translate into an improvement in quality and quantity of prescriptions of these devices in clinical practice. The questions with higher rates of errors in the pre-training test were the questions about the waiting time between two sprays in successive applications and about the correct way to attach the inhaler to the spacer, both with high levels of success in the post-training test.

Keywords: Metered dose inhalers; Inhalation spacers; Knowledge; Asthma

RESUMO

Objetivo: Avaliar o efeito de uma orientação teórico-prática sobre o conhecimento de pediatras a respeito do uso de inaladores dosimetrados com espaçadores. Detectar as principais deficiências,

corrigi-las e capacitar esses médicos para a correta utilização desses inaladores. **Métodos:** Pediatras que participaram de um curso teórico-prático a respeito do uso de dispositivos inalatórios responderam a um questionário com cinco perguntas sobre o uso desses dispositivos antes e após o curso. A comparação entre as notas obtidas no pré e no pós-teste foi feita por meio do teste de Wilcoxon para amostras relacionadas, sendo adotado um nível de significância de 0,05. **Resultados:** Vinte pediatras realizaram o pré e o pós-teste. O desempenho dos médicos no pós-teste foi significativamente melhor que o inicial ($p < 0,001$). **Conclusão:** Um breve programa de orientação a pediatras melhorou de forma significativa o conhecimento desses médicos a respeito do uso de inaladores dosimetrados com espaçadores, fato que pode se traduzir em uma melhora na qualidade e na quantidade de prescrições desses dispositivos na prática clínica. As questões com maiores índices de erros no pré-teste foram a relativa ao tempo necessário entre dois jatos em aplicações sucessivas e a que diz respeito à maneira correta de se acoplar o inalador ao espaçador, todas com altos níveis de acertos no pós-teste.

Descritores: Inaladores dosimetrados; Espaçadores de inalação; Conhecimento; Asma

INTRODUCTION

Respiratory disorders have a significant impact on the quality of life of children and adolescents. Asthma stands out among these diseases and has a prevalence worldwide between 1 and 18%. In Brazil, asthma is the third cause of hospitalization of children and young adults, presenting with acute viral bronchiolitis and diseases that cause recurrent wheezing in

Study carried out at Instituto da Criança, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo – USP, São Paulo (SP), Brazil.

¹ Instituto da Criança, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo – USP, São Paulo (SP), Brazil.

Correspondence: Fábio Pereira Muchão – Hospital Israelita Albert Einstein – Unidade Ibirapuera – Avenida República do Líbano, 501 – CEP 04501-000 – Sao Paulo (SP), Brazil – Tel.: (11) 2151 6122 – E-mail: fabiomuchao@gmail.com

Received: May 16, 2011 – Accepted: Aug 11, 2011

Conflict of interest: none

infants⁽¹⁻⁴⁾. Because of the role of inflammation in the pathophysiology of the disease, today the vast majority of physicians prescribe anti-inflammatory drugs to treat persistent asthma. Infants presenting recurrent wheezing episodes and with risk factors for the early onset of asthma are potential candidates for maintenance therapy^(1,3,5).

Inhaled corticosteroids are the drugs more often studied and broadly used for this type of treatment, and are sometimes associated with long-acting bronchodilators^(1,5). These drugs are available in three types of inhalation devices: conventional nebulizers, dry powder inhalers, metered-dose inhalers^(6,7). Conventional nebulizers are no longer used for this type of therapy. The use of dry powder inhalers is recommended for children over 8 years of age. On the other hand, metered-dose inhalers are extremely safe to use, are portable, provide multiple doses, are not dependent on an energy source, and may be used for all age groups^(6,8,9). Metered-dose inhalers contain a reservoir that is attached to a plastic part which contains a solution of the drug or a suspension containing surfactants, lubricating agents and propellants. Pulmonary deposition with traditional metered-dose inhalers varies between 10 and 20%, the amount of deposition varies according to the type of propellant gas^(10,11). The use of metered-dose inhalers must be encouraged not only for maintenance therapy with inhaled corticosteroids, but also for treatment of acute crises in emergency departments and first-aid units. Asthma treatment with bronchodilators in metered-dose inhalers with spacers is more efficient, causes fewer side effects and is more practical than conventional inhalers^(12,13) because it is easier to trigger the device at the start of inhalation and may double the amount of drug delivered in the lungs^(6,8,14-16).

Treatment failure in asthma patients frequently occurs due to the wrong use of metered-dose inhalers. Numerous studies reveal that the wrong use of metered-dose inhalers by patients is frequently the result of inadequate instruction by health professionals, who are not familiar with the technique⁽¹⁷⁾. Many studies corroborate this finding⁽¹⁷⁻²¹⁾. Similar results have been reported for patients with chronic obstructive pulmonary disease (COPD)⁽²²⁾. Some studies demonstrated that short theory and practice training sessions are effective tools to teach healthcare professionals the correct use of inhalers^(23,24).

The hypothesis of this study was that pediatricians had insufficient knowledge regarding the use of metered-dose inhalers with spacers and that a simple theory-practice training session would significantly improve their knowledge about the use of these devices.

OBJECTIVE

This study was carried out during the “12th Congress of Pediatrics of the State of Sao Paulo”. The primary objective was to evaluate the knowledge of participating pediatricians regarding the use of metered-dose inhalers with spacers. For the purpose of this study participating pediatricians answered a theoretical test. Then they participated in a short theory-practice training session on the use of metered-dose inhalers with spacers. The effect of training was assessed with a post-training test. The secondary objectives were to assess the main deficiencies, to correct them and train these physicians regarding the correct use of the inhalers.

METHODS

The present study, carried out during the “12th Congress of Pediatrics of the State of Sao Paulo”, aimed to evaluate the efficiency of a short education program focused on the knowledge of participating pediatricians regarding the use of metered-dose inhalers with spacers. During the event, held in March 2010, pediatric pneumologists and allergists taught conference participants about the use of inhalers commonly prescribed for pediatric patients, including metered-dose inhalers with spacers. Only pediatricians who voluntarily participated in the teaching sessions were included in the study.

The primary endpoint evaluated whether participant test scores improved after the teaching session. The secondary endpoint was to assess if the physicians gave the correct answers in the post-training test to question with higher rate of mistakes in the pre-test.

Pediatricians who participated in the training sessions were asked to fill out a confidential, unidentified questionnaire containing five closed multiple-choice questions (Appendix 1). Thus study participation was voluntary and included only those who filled out the questionnaire.

After the test, participants attended a theory teaching session, followed by a practice training session. For the practice training session participants were divided into small groups. Each group received practical training and watched demonstrations regarding the use of different inhalers, including metered-dose inhalers with spacers. After completion of the training session participants were asked to answer the questionnaire again.

Median scores of both tests were estimated. Scores from the pre- and post-training tests were compared using the Wilcoxon test for related samples, which tries to determine if it is possible to reject the hypothesis that there is no difference between the median scores of both tests. Level of significance was set at 0.05. Analysis of data was carried out using the PASW Statistics 18.0 (SPSS Inc., Chicago, Illinois, EUA).

RESULTS

A total of 25 pediatricians participated in the course but only 20 took both tests. Comparison of test performance was only carried out for those who took the pre- and post-training tests. Table 1 lists the median scores of both tests.

Participant performance was significantly better in the post-training test than in the pre-training test ($p < 0,001$) (Table 1).

Table 1. Medians obtained in the tests

Pre-training test	Post-training test
4.00 (A) (min 2, max 8)	10.00 (B) (min 6, max 10)

Significant difference between B and A; $p < 0.001$ (Wilcoxon test for related samples).
min: minimum; max: maximum.

Figure 1 presents the distribution frequency of participant scores in the pre- and post-training tests.

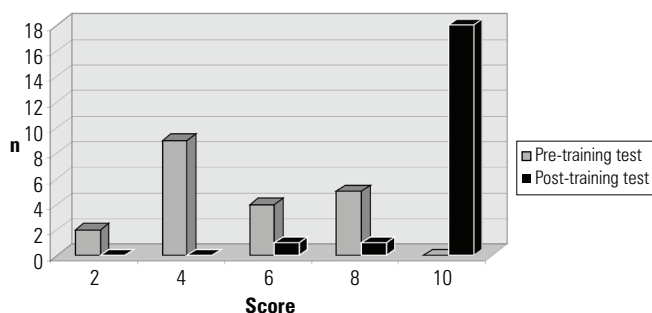


Figure 1. Frequency of distribution of scores obtained by the course students in the pre-training and post-training tests

The majority of participants had problems with question 3 (regarding the time interval between two sprays in successive applications) and question 2 (regarding the correct manner of coupling the inhaler and the spacer). On the other hand the majority of participants correctly answered question 1 (regarding the best manner of using the metered-dose inhaler in infants).

Despite significant reduction in wrong answers, in the post-training test most participants still struggled with questions 3 and 2. Yet, all participants answered questions 1, 4 and 5 correctly.

DISCUSSION

The pre-training test reveals important information gaps regarding knowledge of pediatrician about metered-dose inhalers.

A study with 239 resident physicians of the internal medicine of a tertiary hospital in the city of Sao Paulo

showed that although 70% knew which medication to prescribe for patients with poorly controlled asthma, only 30% were able to correctly demonstrate the use of pressurized metered-dose inhalers⁽¹⁸⁾.

Another study carried out at the Instituto da Criança - Hospital das Clínicas - Faculdade de Medicina da Universidade de São Paulo (FMUSP), a tertiary pediatric hospital in the city of Sao Paulo (SP), evaluated the theoretical and practical knowledge of resident physicians, assistant physicians, physical therapists, nurses and nursing technicians about the use of metered-dose inhalers with spacers. The study revealed that general knowledge of healthcare professionals regarding this type of device was not satisfactory. According to this study, the nursing professionals, who are directly involved in the practice of administering drugs, performed worst than physicians and physical therapists, who had similar performance⁽²¹⁾.

Similar to our study with pediatricians in the congress, in the aforementioned study participants had more difficulty to answer questions regarding the correct procedure when two consecutive deliveries are needed and questions regarding the correct coupling of the inhaler and the spacer⁽²¹⁾.

In medical practice, these gaps of knowledge are associated with poor patient instruction, which in turn leads to lower efficacy of maintenance and rescue therapy with metered-dose inhalers with spacers.

Another interesting result is associated with the high number of correct answers of question 1, regarding the use of spacers in infants. At the Instituto da Criança, the majority of study participants answered this question correctly. This demonstrates that in the case of infants, healthcare professionals are aware of the importance of the use of dose-metered inhalers with spacers, and show reasonable knowledge regarding their use. However, there are severe deficiencies in terms of patient instruction, especially in the case of school-aged children and adolescents⁽²¹⁾. Results from the study with professionals at the Instituto da Criança show that a large number of professionals (in all categories) failed to prescribe spacers for school-aged children⁽²¹⁾. This is in line with data reported by Cunha et al., who performed a prospective study with 78 pediatricians working in public healthcare units in Rio de Janeiro, and observed that 70% did not prescribe the use of spacers on a routine basis. Out of these, 8% did not prescribe inhaled medication at all, 18% considered that the use of spacers was too complicated, 29% considered them expensive, and 28% pointed out that spacers were not available for use the public healthcare services. But, the most alarming data is that 58% of these physicians mentioned poor understanding of the use and function of spacers⁽²⁰⁾.

The function of the spacer is to facilitate the use of inhaled medication by children who are unable to coordinate triggering of the device and the start of inhalation. Yet, school children and teenagers also benefit from these devices, because they retain large particles (that do not reach the distal airways) so that smaller particles reach peripheral airways, thus maximizing therapeutic effects and minimizing side effects⁽²⁵⁾.

The dramatic improvement of test performance after the training session shows that a simple and objective approach may dramatically change the picture of general knowledge of these professionals. This is in line with data reported in the medical literature^(23,24).

Results similar to those reported in the present study were described in a randomized controlled study carried out at a hospital, in Philadelphia, that evaluated the capacity of resident physicians to use metered-dose inhalers with spacers, before and after implementation of a two-month theory-practice training program. At the end of the study, the performance of residents who participated in the training program improved were compared to their own initial performance and improved significantly as compared to results from the control group⁽²³⁾.

Following the same line of study design, in South Korea, 142 residents from 6 hospitals tested the knowledge of study participants regarding the use of dry-powder inhalers and pressurized metered-dose inhalers before and 2 months after a single training session on the use of these devices. At the end of the study physicians' knowledge regarding the use of the three types of inhalers had improved significantly⁽²⁴⁾.

Training programs can contribute to the improvement of inhalation technique in patients. A multicenter study with 349 users of inhalers demonstrated that an instruction session with a healthcare professional significantly improved theoretical and practical knowledge of these patients regarding the use of metered-dose inhalers, spacers and dry-powder inhalers, two and eight months after the instruction session⁽²⁶⁾.

Some events, such as the "Congress of Pediatrics of the State of Sao Paulo", may be a good opportunity to spread information. Simple education programs may be set up in teaching-hospitals, in order to build a critical mass of professionals (physicians, nurses, physical therapists) who are capable of applying information in practice and are able to convey said concept to other healthcare professionals working in different units. Even video-training-session may be effective and more viable from the economic point of view. Lim et al. demonstrated that patients and healthcare professionals were highly satisfied with a video-assisted program that focused on improving inhalation techniques⁽²⁷⁾.

Proper training of healthcare professionals would certainly increase the use of metered-dose inhalers with spacers in all levels of public health care. This could result in considerable cost reduction for the Brazilian health system. A study carried out with patients suffering from chronic obstructive pulmonary disease, treated in a private tertiary hospital in the USA, concluded that replacing conventional nebulizers with pressurized metered-dose inhalers with spacers for the delivery of bronchodilating agents would result in a cost reduction by US\$ 253,487 per year⁽²⁸⁾. In a tertiary hospital in North Carolina, the replacement of nebulizers with pressurized metered-dose inhalers with spacers reduced costs from US\$ 27,600 ± 2,277 to US\$ 20,618 ± 2,086 ($p = 0.008$) per month; and cost for the patients decreased by approximately US\$ 300,000 a year. Furthermore, the amount of time health professionals spent administering medication decreased from 1,576 ± 131 hours to 992 ± 116 hours ($p = 0.002$)⁽²⁹⁾. It is important to point out that even home-made spacers made from plastic bottles, are efficient and extremely cheap, and represent one of the cost reduction possibilities for the use of metered-dose inhalers with spacers⁽³⁰⁾.

It is important to point out a few limitations of this study. The selection of the study population (only pediatricians who voluntarily enrolled for the training sessions) could have influenced the results, since those were individuals who certainly needed to improve their knowledge about the use of these devices (which could explain the poor initial performance). As a consequence the high interest of these pediatricians in the subject may explain the dramatic improvement in the post-training test. Also, the presence of pediatricians who specialized in pneumology or allergy could have influenced the results. This is highly unlikely since physicians who answered the questionnaire were not familiar with inhalation techniques and devices. Another fact worth mentioning is that the size of the sample population depended on the number of physicians participating in the training session and that only those who responded the questionnaires were included.

CONCLUSIONS

Knowledge of pediatricians regarding the use of metered-dose inhalers with spacers is poor and a short training session significantly improved understanding of these devices. This may translate into an improvement in quality and in amount of prescriptions for the use of these devices in the clinical practice of these professionals.

Questions regarding the interval between two deliveries in consecutive applications and questions regarding the correct coupling of the inhaler and the

spacer had higher error rates in the pre-training test. This was corrected after the training session since error rate significantly decreased in the post-training test.

ACKNOWLEDGEMENTS

The authors thank all pediatric pneumologists and allergists specialists who contributed with the training sessions, since their work was of utmost importance for this study.

REFERENCES

- Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGerald M, et al. Global strategy for asthma management and prevention: GINA executive summary. *Eur Respir J*. 2008;31(1):143-78.
- Solé D, Wandalsen GF, Camelo-Nunes IC, Naspitz CK; ISAAC - Brazilian Group. [Prevalence of symptoms of asthma, rhinitis, and atopic eczema among Brazilian children and adolescents identified by the International Study of Asthma and Allergies in Childhood (ISAAC) - Phase 3]. *J Pediatr (Rio J)*. 2006;82(5):341-6. Portuguese.
- Martinez FD, Wright AL, Taussig LM, Holberg CJ, Halonen M, Morgan WJ. Asthma and wheezing in the first six years of life. The Group Health Medical Associates. *N Engl J Med*. 1995;332(3):133-8.
- Benício MH, Ferreira MU, Cardoso MR, Konno SC, Monteiro CA. Wheezing conditions in early childhood: prevalence and risk factors in the city of São Paulo. *Bull World Health Organ*. 2004;82(7):516-22.
- Sociedade Brasileira de Pneumologia e Tisiologia. IV Diretrizes Brasileiras para o Manejo da Asma. *J Bras Pneumol*. 2006;32:S447-S474.
- Rubin BK, Fink JB. The delivery of inhaled medication to the young child. *Pediatr Clin North Am*. 2003;50(3):717-31.
- Dolovich MB, Ahrens RC, Hess DR, Anderson P, Dhand R, Rau JL, Smaldone GC, Guyatt G; American College of Chest Physicians; American College of Asthma, Allergy, and Immunology. 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(1):335-71.
- Biggart E, Bush A. Antiasthmatic drug delivery in children. *Paediatr Drugs*. 2002;4(2):85-93.
- Pedersen S. Choice of inhalation therapy in paediatrics. *Eur Respir J*. 1994;18(1):85-8.
- Ashworth HL, Wilson CG, Sims EE, Wotton PK, Hardy JG. Delivery of propellant soluble drug from a metered dose inhaler. *Thorax*. 1991;46(4):245-7.
- Ibiapina CC, Cruz AA, Camargos PA. [Hydrofluoroalkane as a propellant for pressurized metered-dose inhalers: history, pulmonary deposition, pharmacokinetics, efficacy and safety]. *J Pediatr (Rio J)*. 2004;80(6):441-6. Portuguese.
- Cates CJ, Crilly JA, Rowe BH. Holding chambers (spacers) versus nebulisers for beta-agonist treatment of acute asthma. *Cochrane Database Syst Rev*. 2006;(2):CD000052.
- Chong Neto HJ, Chong-Silva DC, Marani DM, Kuroda F, Olandosky M, Noronha L. [Different inhaler devices in acute asthma attacks: a randomized, double-blind, placebo-controlled study]. *J Pediatr (Rio J)*. 2005;81(4):298-304. Portuguese.
- Tashkin DP. New devices for asthma. *J Allergy Clin Immunol*. 1998;101(2 Pt 2):S409-S16.
- Brand PL, Roorda RJ. Drug Delivery in Pediatric Patients with Asthma: Spacer Devices vs Nebulizers for [beta]2 Agonists. *Am J Drug Delivery*. 2003;1(1):61-70.
- Demirkan K, Tolley E, Mastin T, Soberman J, Burbeck J, Self T. Salmeterol administration by metered-dose inhaler alone vs metered-dose inhaler plus valved holding chamber. *Chest*. 2000;117(5):1314-8.
- Plaza V, Sanchis J. Medical personnel and patient skill in the use of metered dose inhalers: a multicentric study. CESEA Group. *Respiration*. 1998;65(3):195-8.
- Stelmach R, Robles-Ribeiro PG, Ribeiro M, Oliveira JC, Scalabrini A, Cukier A. Incorrect application technique of metered dose inhalers by internal medicine residents: impact of exposure to a practical situation. *J Asthma*. 2007;44(9):765-8.
- Owayed A, Al-Ateeqi W, Behbehani N. Proficiency of pediatricians in the use of inhaled medication delivery systems for the management of asthma. *J Asthma*. 2006;43(6):459-62.
- Cunha AJ, Santos MA, Galvao MG, Ibiapina AA. Knowledge of pediatricians in Rio de Janeiro, Brazil, about inhalation therapy in asthmatic children. *Allergol Immunopathol (Madr)*. 2003;31(2):87-90.
- Muchão FP, Perin SL, Rodrigues JC, Leone C, Silva Filho LV. [Evaluation of the knowledge of health professionals at a pediatric hospital regarding the use of metered-dose inhalers]. *J Bras Pneumol*. 2008;34(1):4-12. Portuguese.
- Souza ML, Meneghini AC, Ferraz E, Vianna EO, Borges MC. [Knowledge of and technique for using inhalation devices among asthma patients and COPD patients]. *J Bras Pneumol*. 2009;35(9):824-31. Portuguese.
- Amirav I, Goren A, Kravitz RM, Pawlowski NA. Physician-targeted program on inhaled therapy for childhood asthma. *J Allergy Clin Immunol*. 1995;95(4):818-23.
- Kim SH, Kwak HJ, Kim TB, Chang YS, Jeong JW, Kim CW, et al. Inappropriate techniques used by internal medicine residents with three kinds of inhalers (a metered dose inhaler, Diskus, and Turbuhaler): changes after a single teaching session. *J Asthma*. 2009;46(9):944-50.
- Duerden M, Price D. Training issues in the use of inhalers. *Dis Manag Health Outcomes*. 2001;9(2):75-87.
- Giner J, Macián V, Hernández C; Grupo EDEN. [Multicenter prospective study of respiratory patient education and instruction in the use of inhalers (EDEN study)]. *Arch Bronconeumol*. 2002;38(7):300-5. Spanish.
- Lim T, Kong M, Lin F, Chee M, Tan F, Tan K. A Pilot Project of Inhaler Technique in the Multimedia Format for Asthma Education. [Abstract]. *J Allergy Clin Immunol*. 2009;123(2) Suppl 1:S65
- Jasper AC, Mohsenifar Z, Kahan S, Goldberg HS, Koerner SK. Cost-benefit comparison of aerosol bronchodilator delivery methods in hospitalized patients. *Chest*. 1987;91(4):614-8.
- Bowton DL, Goldsmith WM, Haponik EF. Substitution of metered-dose inhalers for hand-held nebulizers. Success and cost savings in a large, acute-care hospital. *Chest*. 1992;101(2):305-8.
- Vilarinho LC, Cardeal Mendes CM, de Freitas Souza LS. [Metered-dose inhalers with home-made spacers versus nebulizers to treat moderate wheezing attacks in children]. *J Pediatr (Rio J)*. 2003;79(5):403-12. Portuguese.

Appendix 1. Theoretical evaluation**1- What is the best way to use a pressurized metered-dose inhaler in infants?**

- a- Applying the spray 30 cm away from the patient's face, with no spacer, since infants do not coordinate breathing and spray application.
- b- Applying the spray with spacer, but leave it for just 5 seconds in contact with the patient's face to avoid babies to inhale an excessive amount of the drug.
- c- This type of inhaler is not adequate to use in infants.
- d- Applying the spray with spacer and mask, but leave it in contact with the patient's face until the infant breathes completely for six times, enabling inhaling of all drug available. **(correct)**

2- How should the metered-dose inhaler be coupled to the spacer?

- a- With the reservoir upwards and the outlet downwards. **(correct)**
- b- The position of the inhaler is not important, but it must be assured that the system has no leakage.
- c- With the reservoir upwards and the outlet upwards, avoiding impaction of drug particles in the spacer, which could hinder delivery of the drug to the patient's airways.
- d- The position of the inhaler in relation to the spacer does not interfere in delivery of the drug to the pulmonary territory.

3- The time interval between two sprays should be:

- a- 5 seconds.
- b- 10 seconds.
- c- 1 minute. **(correct)**
- d- Immediately after the first spray.

4- For correct spary inhaling in a school-aged patient, inspiration should be:

- a- Quick and shallow.
- b- Quick and deep.
- c- Slow and deep. **(correct)**
- d- It is important that the patient keeps the mouth coupled to the spacer for 30 seconds.

5- Spacers should be cleaned:

- a- Daily, with water and detergent, and later wiped dry using a cloth.
- b- Daily, only with water, and later wiped dry using a cloth.
- c- Once a week, with water and detergent, and let it naturally dry out. **(correct)**
- d- Once a week, with bleach solution, for correct disinfection.