# INHALER TECHNIQUE IN A PEDIATRIC EMERGENCY DEPARTMENT: IMPACT OF AN EDUCATION INTERVENTION AMONG HEALTHCARE PROFESSIONALS

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**Abstract**

**Background**: Inhaler technique (IT) knowledge among healthcare providers is poor. The aim was to improve PED healthcare providers' IT technique by carrying out an education intervention, and sustain it for 6 months. **Methods:** open-label, quasi-experimental, prospective and unicentric study. Healthcare professionals working at the Pediatric Emergency Department (PED) were enrolled. The study was developed in three phases: baseline evaluation and education intervention (P1) and reevaluation 1 month (P2) and 6 months (P3) after the education intervention. Participants fulfilled an eight-question theoretical test. Practical skills were evaluated by demonstrating IT in all three phases. The education intervention consisted in a verbal explanation of IT followed by a demonstration of IT with metered-dose inhaler using a mannequin. **Results:** 84 healthcare providers (medical residents, nurses and nursing assistants) were involved. In the theoretical questionnaire, the mean score at baseline was 4.4/8 (SD 1.7) improving to 6.3/8 (SD 1.2) in P2 and 6.47/8 (SD 1.1) in P3. In the IT evaluation for children <7 years old, the score improved from 5.7/7 (SD1.3) to 6.5/7 in P2 and 6.7/7 in P3 ($p<0.001$). For children >7 years old, the mean score of IT at baseline was 3.1/10 (SD 4), which improved to 7.4/10 (SD3) and 8.2/10 in P2 and P3 respectively ($p<0.001$). Only laboral category influenced results at baseline. **Conclusion:** Healthcare providers' theoretical knowledge and practical skills on IT are low. The education intervention performed is a useful strategy to ameliorate IT among healthcare providers.

## INTRODUCTION

Asthma exacerbations are one of the main reasons for presentation to the Pediatric Emergency Department (PED), representing 5% of all consultations[1]. Performing inhaler technique (IT) correctly is a simple but effective method to improve asthma control in children[2-4]. However, many reports have shown that the majority of the healthcare providers involved in caring for patients with respiratory diseases, including doctors and nurses, have poor knowledge of IT[5-7].

It is known that inadequate IT is related to poorer asthma control, which can cause an increase in the number of Emergency Department visits, hospital admissions and school absenteeism[8]. The optimal way of using inhaled medication with metered-dose inhaler (MDI) depends on the age and ability of the patient[2]. However, it is common to find discrepancies regarding the information given to the patients and their families due to a lack of knowledge of healthcare providers on this matter. This problem has been recently addressed in the adult population. Morton et al pointed out that many asthmatic patients are managed by non-asthma specialists who, themselves, may not know how to use an inhaler device and consequently, do not know how to teach IT correctly[9]. Additionally, Plaza et al performed a systematic review in which they analyzed healthcare professionals' IT knowledge: only 15,5% performed IT correctly, with a downward trend over time during the study period[10].

Unfortunately, few studies have been conducted with healthcare professionals in pediatric settings, and even fewer in emergency units. Among the studies performed in PED, Spaggiari et al. assessed IT in nurses and pediatricians, observing that IT was perfectly mastered by 49% of the participants and almost perfectly mastered by another 34%, highlighting that nurses obtained better results than doctors[11]. These results underline the need of "training trainers", hence, the importance of conveying training programs addressed to healthcare providers. The analysis of the impact of education interventions in healthcare providers have been predominantly performed with medical intern residents (MIR). Single or repeated instruction sessions, which include a theoretical lecture and practical demonstration of IT, have demonstrated to improve IT performance among MIR, however, no studies have been performed analyzing the impact of training programs with other professional categories nor in the PED[13,14].

Therefore, this study was designed to evaluate if an education intervention was an effective strategy to provide information about IT for healthcare professionals in a PED. The main aim of this study was to improve PED healthcare providers' IT technique by carrying out an education intervention and sustain it for 6 months. We evaluated IT among different healthcare categories (doctors, nurses and nursing assistants) and evaluated which factors influenced baseline results.

## METHODS

### Study population

We enrolled healthcare professionals (medical intern residents or MIR, nurses and nursing assistants), working at the PED during the study period. We excluded those who had a temporary contract, considered as shorter than 2 months.

### Trial design

The study was open-label, quasi-experimental, prospective and unicentric study developed in a PED of a third-level Spanish hospital which receives 58,000 emergencies annually. The study took place between June 2020 and February 2021. The trial was approved by the hospital's Institutional Review Board.

### Development of the education intervention

In the first place, the main problems regarding IT were identified. We developed a key driver diagram to analyze these problems and planned an education intervention which would approach each of them (Figure 1). In order to reduce interobserver bias, only two of the main investigators were responsible for performing the education intervention and participants' evaluation. Both investigators received specific IT training by Pediatric Pneumologists.

A standardized educational checklist was created to evaluate IT, which was designed following Spanish guidelines recommendations (Spanish Pediatric Pneumology Association) and standardized checklists used in previous studies[15].

The study was developed in three phases: baseline evaluation and education intervention (phase 1), and revaluation 1 month (phase 2) and 6 months after the education intervention (phase 3).

Phase 1 (P1): baseline evaluation and education intervention.

*Baseline evaluation*

Baseline evaluation consisted in the evaluation of IT theoretical knowledge and practical skills.

Theoretical knowledge evaluation: healthcare professionals were asked to fill-in a written test which included 8 questions regarding MDI IT (see Appendix I). Each correct answer scored 1 point, up to a total of 8 points.

Practical skills evaluation: participants were asked to perform IT with space chamber and facemask and with a space chamber with mouthpiece (with apnea). IT with a space chamber and facemask was to be performed with a mannequin. In the case of IT with a space chamber and mouthpiece, they were asked to perform IT themselves.

Evaluators fulfilled a checklist with the steps to be accomplished: 7 steps if facemask was used in addition to spacer and 10 steps if only spacer with mouthpiece was used (Table 1). Each step of the checklist performed correctly scored 1 point. Failing to perform any one of these steps or not performing IT according to patients' age was evaluated as an inadequate technique.

Additionally, demographic information was recorded: age, professional category, years of experience in PED, asthmatic personal background, previous specific IT training and if they modified IT in their daily practice.

*Education intervention*

Once the initial questionnaire was completed and after having evaluated IT, the education intervention was performed. A 15-minute course about IT was imparted, which included a verbal explanation of IT essential ideas supported by multimedia (power-point presentation). Emphasis was given to the importance of adapting IT to patients' age and abilities. Subsequently, a demonstration of MDI IT was performed. IT with a space chamber and facemask was demonstrated using a mannequin, while IT with a space chamber and mouthpiece was performed by one of the main investigators, exemplifying how to perform each step.

Phase 2 (P2) and phase 3 (P3): Reevaluation.

The impact of the education intervention was evaluated one month (phase 2) and 6 months (phase 3) after the education intervention. Firstly, participants filled-in the same questionnaire as in P1. Three additional questions were included: perceived satisfaction and usefulness of the education intervention (in a score 0 to 10), as well as if the intervention had entailed a change in daily practice. Secondly, subjects demonstrated IT using a mannequin for IT with facemask and space chamber and doing it themselves for IT with only space chamber with mouthpiece). IT was evaluated using the same checklists as in P1. We considered an effective educational intervention if an upgrade of 1 point in the total score of the IT was achieved with respect to the score in P1.

### Statistical analysis

To analyze qualitative variables, we used percentages and to analyze quantitative variables average with standard deviation or median with interquartile range (IQR), depending on the normality of distributions. For the comparison of quantitative measures we used Student's T test or Wilcoxon test depending on the normality of distributions. In order to evaluate the impact of the education intervention, we calculated the difference between the scores obtained in the theoretical questionnaire and practical skills in P2 and P3 with respect to baseline (P1). Linear models were fitted, and beta-regression coefficients were calculated to link quantitative variables. Statistical significance was considered $p<0.05$. We performed a multivariable analysis to determine the factors that determined a variation in the scores at baseline, using multivariable linear regression, which will include those independent variables with at least a trend to statistical significance ($p<0.10$) in the univariable analysis.

## RESULTS

### Subjects

From June 2020 to February 2021, 84 healthcare providers were assessed for eligibility. Out of the 84 healthcare providers, all of them participated in P1 (100%), 68 (80%) participated in P2 and 74 (88%) in P3. 65 of them (77%) completed the 3 phases of the study. Demographic characteristics are displayed in Table 2.

### Impact of the education intervention

Globally, the scores obtained in P2 and P3 in the theoretical questionnaire and practical evaluation, were higher with respect to P1. The mean scores at each phase are shown in Table 3 in addition to the results obtained in the different phases by different healthcare professional categories.

### Baseline healthcare professionals' inhaler technique knowledge

Theoretical questionnaire

Regarding the theoretical questionnaire, 68 subjects (81%) answered that IT varies according to the patients' age. Only 20 of the participants (23.8%) answered correctly to the question "at what age does inhaler technique vary?". With respect to IT in children over 7 years old, only 13 (15.5%) answered how to perform IT correctly. The theoretical questionnaire and the correct answers are provided as Supplementary material.

Inhaler technique evaluation

At baseline (P1), the most challenging step on IT in children younger than 7 years old, was "waiting 30-60 seconds between inhalations" (41.7%). In children older than 7 years old, the most challenging step was performing a "deep exhalation" prior to pressing the inhaler canister (16.7%). Globally, scores obtained in the assessment of IT of space chamber with facemask were higher than those obtained with space chamber and (Table 4).

**Predictors of correct inhaler technique and theoretical evaluation in phase 1**

At baseline, there were statistical significant differences between the scores obtained by different laboral categories in the theoretical test (MIR 6.2/8 points SD 1.1, nurses 3.9/8 points, SD 1; nursing assistants: 3.2/8 points, SD 1.4, p<001), IT with space chamber and facemask (MIR 6/7 points SD 1.1, nurses 5.9/7 points, SD 1; nursing assistants: 4.9/7 points, SD 1.6, p<001) and IT with space chamber and mouthpiece (MIR 6.4/10 points SD3.9, nurses 1.8/10 points, SD 3.3; nursing assistants: 1.9/10 points, SD 3.2, p<001). Asthmatic participants obtained better scores with respect to non-asthmatic participants in IT evaluation with space chamber and mouthpiece (5.5/10 points SD 1 and 2.6/10 points, SD 1.4, respectively [p0.029]), however no differences were detected in the scores obtained in the theoretical test (4.2/8 points, SD 1.6 and 5/ 8 points, SD 1.7 respectively [p0.147]) and practical IT evaluation with space chamber and facemask (5.5/7 points SD 1.4 and 5.9/7 points SD 0.87, p0.428). No differences were detected in participants who had participated in IT courses previously with respect to those who had not in the theoretical test nor in either of the IT techniques.

In the regression lineal models, age (B-0.05, p<0.001) and years of experience in the PED (B-0.03, p0.095) were inversely related to the theoretical questionnaire scores. Statistically significant differences were detected between scores obtained by different healthcare professional categories (MIR 6.2, SD 1.1, nurses 3.9, SD 1; nursing assistants: 3.2, SD 1.4, p<0001). However, in the multivariable analysis, only laboral category influenced results in P1 (B-1.3, p<0.001), see Figure 2.

With respect to IT in children <7 years old, laboral category was the only factor that influenced baseline results (MIR 6, SD 1.1, nurses 5.9, SD 1; nursing assistants: 4.9, SD1.6, p<0.001). In IT evaluation of children >7 years old, age (B-0.07, p<0.001), laboral category (MIR 6.38, SD 3.9, nurses 1.8, SD 3.3; nursing assistants: 1.9, SD3.2, p<0.001) and asthma (5.5, SD 4.8; p0.02) influenced scores in P1. In the multivariable analysis, only laboral category influenced these results (p<0.001).

**Satisfaction questionnaire, perceived utility and impact in daily practice**

Healthcare providers considered the intervention useful (medium score 9.5 over 10 points in P2, SD 0.8, 9.44 in P3, SD 0.9) and the satisfaction level was high (9.6 in P2, SD0.8, 9.5 in P3 over 10 points, SD 0.8).

Lastly, at baseline 56 subjects (66.7%) sustained that they changed IT according to patients' age in their daily practice, which remained stable at P2, and increased to 61 subjects (72.6%) at P3.

## DISCUSSION

The present study assesses the impact of an education intervention in a PED on healthcare providers' theoretical knowledge and practical skills about IT and how it varies during the study period. We observed that after an education intervention, theoretical and practical knowledge on IT improves among healthcare providers and it remains for at least six months.

Concerning the impact of the education intervention performed, scores of the theoretical questionnaire and practical skills improved globally and in all healthcare groups. These results are consistent with previous studies, which have been mainly performed with MIR[14,15,18]. Unlike other studies, we evaluated the impact twice after the education intervention: in the short (one month) and medium term (6 months). Globally, better scores were obtained in P3 with respect to P2, probably due to the fact that, after evaluation in P2, we explained and rectified mistakes. Therefore, this strategy validates the need of repeated training in order to acquire correct IT. Additionally, we observed a greater improvement in IT with space chamber and mouthpiece with respect to IT with space chamber and facemask secondary to scarce initial knowledge about the use of the former, which goes in parallel with the findings of previous studies[19].

As a secondary endpoint, we evaluated IT theoretical knowledge and practical skills among healthcare providers. At baseline, we obtained global poor results in theoretical and practical skills. In line with our findings, Satambrogio et al found that the medium score in the evaluation of IT was 9.9 over a total score of 21 and that none of the participants answered correctly to all the theoretical questions[7]. Similarly, Spaggiari et al conducted a study in the PED, detecting that only 49% of participants did all the steps correctly in the practical examination and 34% almost perfectly[12].

Regarding practical skills, the scores of IT with space chamber and mouthpiece were lower than when facemask was added. Likewise, Satambrogio et al found that healthcare professionals committed a lower number of errors in IT with space chamber and facemask[7]. We also analyzed specifically which steps were the best and worst performed. On one hand, up to 96.4% set-up the inhaler device correctly and 92.9% pressed the canister just once for each inhalation when performing IT with a space chamber and facemask. However, less than half of the participants (41.7%) awaited 30-60 seconds between inhalations. In contrast to our findings, Spaggiari et al found that the most mistaken step was shaking the canister before the next inhalation and patients' position during IT[12]. On the other hand, the most forgotten step in IT with space chamber and mouthpiece was taking a deep exhalation before inhalation (75%) followed by exhaling slowly after inhalation (79.8%). Similar results were obtained in a systematic review by Plaza et al[11]. However, in other studies, the most frequent errors were not breath-holding after inhalation and not waiting a minute before the next inhalation[7]. These results are especially important, as identifying gaps in knowledge regarding proper IT is essential to impart continued education programs.

We also evaluated predictors of theoretical and practical knowledge at baseline. Regarding the theoretical questionnaire, MIR obtained better scores than nurses and nursing assistants. Both age and number of years of experience in PED were inversely related to these scores. However, in the multivariable analysis, only the laboral category influenced these results. This can be explained by the fact that, in our hospital, MIR follow a specific program in which they are trained in IT, hence, having better scores despite being younger and having fewer years of experience. Previous studies did not find differences between age or years of experience either[7]. With respect to practical skills, MIR obtained better results than nurses. In contrast, previous studies observed that nurses obtain higher scores than physicians. This finding has been attributed to scarce specific education to medical doctors on this subject due to the fact that nurses are the ones who usually conduct and teach IT[6,7,12]. Additionally, we obtained that asthmatic participants obtained higher scores in IT with space chamber and mouthpiece, as this technique is similar to IT in adults. Interestingly, they did not get better results in the theoretical questionnaire nor in IT with space chamber and facemask, as already reported by Madueño et al[20].

Lastly, participants were highly satisfied after the education intervention. However, we cannot compare our results with other training programs due to the lack of studies regarding healthcare professionals satisfaction after an IT education intervention.

Prescription of MDI should always be associated with proper information and training of the use of the specific inhaler prescribed[21,22]. However, our study corroborates the lack of knowledge and incorrect IT among healthcare professionals, hampering the possibility of teaching IT correctly. Unlike other studies, our study sheds light to this situation by providing an intervention which improves healthcare professionals' IT knowledge and practical skills in the short and medium term. Additionally, it proved useful at introducing

IT with space chamber with mouthpiece, allowing healthcare professionals in the PED to teach IT according to the patient's needs. Enhancing correct IT training in the PED can improve asthma control and, therefore, patients' adherence to treatment[23].

Our study should be considered in light of its limitations. Due to the unicentric characteristics of our study, the impact of the education intervention is limited. However, it could be extended to other centers in order to homogenize knowledge and practical skills of healthcare professionals locally or nationally. Global results could have been influenced by stress, as participants were recruited during their working shift. Additionally, results could have been influenced by the fact of being observed and knowing the study was underway (Hawthorne effect). Due to the impact of COVID pandemic on PED visits, we have not been able to measure clinical outcomes such as hospital admission or return visits. The number of PED visits have reduced drastically in consequence of pandemic, having attended 50% fewer patients for an acute asthma episode with respect to prepandemic situation. Additionally, admission rates have increased from an 11.8% in 2019 to 15% in 2020. This could be due to the fact that only children with moderate and severe asthma episodes consulted PED during pandemic. This fact implies an important bias upon admission rates and in consequence, we considered admission rates not to be a useful outcome to measure the impact of the education intervention performed in our study. Lastly, the number of participants in each phase varies, due to different circumstances such as vacation periods (phase 2 was performed in summer) and to working shifts and inpatient redistribution (specially nurses and nursing assistants) due to pandemic situation.

## CONCLUSION

Healthcare providers' theoretical knowledge and practical skills on IT are low. The education intervention proposed in our study, has proved to be a useful strategy to ameliorate IT among healthcare providers. However, more studies must be performed to establish which is the best training program to address this problem.

*REFERENCES*

1. Johnston NW, Sears MR. The epidemiology of asthma exacerbations. Thorax. 2006;61:722-8.
2. Ammari WG, Chrystyn H. Optimizing the inhalation flow and technique through metered dose inhalers of asthmatic adults and children attending a community pharmacy. Journal of Asthma 2013;50(5):505-513.
3. Burkhart PV, Rayens MK, Bowman RK. An evaluation of children's metered-dose inhaler technique for asthma medications. Nursing Clinics 2005;40(1):167-182.
4. Van Aalderen WM, Garcia-Marcos L, Gappa M, Lenney W, Pedersen S, Dekhuijzen R, Price D. How to match the optimal currently available inhaler device to an individual child with asthma or recurrent wheeze. NPJ primary care respiratory medicine 2015;25(1):1-7.
5. Hanania NA, Wittman R, Kesten S, Chapman KR.. Medical personnel's knowledge of and ability to use inhaling devices: metered-dose inhalers, spacing chambers, and breath-actuated dry powder inhalers. Chest 1994;105(1):111-116.
6. Santambrogio M, Lazzeri M, Bonitta G, Guarise R, Simonetta E, Blasi F, Privitera E. Hospital staff practical skills and theoretical knowledge in inhaled aerosol therapy: a single centre cross-sectional observational study. Monaldi Archives for Chest Disease 2021;91(1).
7. Adeniyi BO, Adebayo AM, Ilesanmi OS, Obaseki DO, Akinwalere OO, Erhabor GE. Knowledge of spacer device, peak flow meter and inhaler technique (MDIs) among health care providers: an evaluation of doctors and nurses. Ghana Med J 2018;52(1):15-21.
8. Harnett C, Hunt E, Bowen B, O'Connell O, Edgeworth D, Mitchell P, Eustace JA, Henry MT, Kennedy MP, Plant BJ, Murphy DM. A study to assess inhaler technique and its potential impact on asthma control in patients attending an asthma clinic. Journal of Asthma 2014;51(4):440-445.
9. Morton RW, Elphick HE, Craven V, Shields MD, Kennedy L. Aerosol Therapy in Asthma-Why We Are Failing Our Patients and How We Can Do Better. Front Pediatr 2020 Jun 11;8:305.
10. Plaza V, Giner J, Rodrigo GJ, Dolovich MB, Sanchis J. Errors in the use of inhalers by health care professionals: a systematic review. J Allergy Clin Immunol Pract 2018 6:987–95.

11. Spaggiari S, Gehri M, Di Benedetto L, Hafen GM, Pauchard J-Y, Gervaix A, Pannatier A, Sadeghipour F, Di Paolo ER. Inhalation technique practical skills and knowledge among physicians and nurses in two pediatric emergency settings. Journal of Asthma 2019:1-7.
12. Gardenhire DS, Burnett D, Strickland S, Myers T. A guide to aerosol delivery devices for respiratory therapists. 4th Edition. American Association for Respiratory Care 2017: 61.
13. Kim S, Kwak HJ, Kim T, Chang Y, Jeong J, Kim C, Yoon HJ, Jee YK. 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. Journal of Asthma 2009;46(9):944-950.
14. Amirav I, Goren A, Kravitz RM, Pawlowski NA. Physician-targeted program on inhaled therapy for childhood asthma. J Allergy Clin Immunol 1995;95(4):818-823.
15. Welch MJ, Martin, ML, Williams PV, Gallet CL, Miller M, Bennett AV, May RW, Lampl KL, Ramachandran S. (2010). Evaluation of inhaler device technique in caregivers of young children with asthma. Pediatric Allergy, Immunology, and Pulmonology, 23(2), 113-120.
16. Spanish Pediatric Pneumology Association neumoped.org. (2020). ACTION PLAN: ASTHMA TREATMENT. [online] Available at: http://fr.zone-secure.net/84369/805660/#page=1 [Accessed 2 Mar. 2021].
17. Salcedo A, Cimadevilla J.L. Sistemas de inhalación. In: Casado J, Serrano A, editors. Urgencias y tratamiento del niño grave. 3ª edición. Síntomas guía, técnicas y cuidados intensivos. Madrid: Majadahonda: 2015. p 268.
18. Rebuck D, Dzyngel B, Khan K, Kesten S, Chapman KR. The effect of structured versus conventional inhaler education in medical housestaff. Journal of Asthma 1996; 33:385–393.
19. Muñoz X, Álvarez C, Maurente L, Chamorro F, García L, Pinchak C. Técnica de terapia inhalatoria: evaluación de una intervención educativa realizada a estudiantes de Medicina, posgrados de Pediatría y cuidadores de niños y adolescentes internados en un hospital pediátrico de referencia. Período junio-agosto de 2019. Archivos de Pediatría del Uruguay 2020;91:43-48.
20. Caro AM, Olmedo PM, Martí EG, Rodríguez EB. Evaluación del conocimiento teórico-práctico de los sistemas de inhalación en médicos de atención primaria, posgrados en formación y pregrado. Atención Primaria 2000;25(9):639-643.
21. Plaza V, Peiro M, Torrejon M, Fletcher M, Lopez-Vina A, Ignacio JM, Quintano JA, Bardagí S, Gich I. A repeated short educational intervention improves asthma control and quality of life. Eur Clin Respir J 2015 Nov;46(5):1298-1307.
22. Sanchis J, Gich I, Pedersen S, Aerosol Drug Management Improvement Team. Systematic review of errors in inhaler use: Has patient technique improved over time? Chest 2016;150:394-406.
23. Capanoglu M, Dibek Misirlioglu E, Toyran M, Civelek E, Kocabas CN. Evaluation of inhaler technique, adherence to therapy and their effect on disease control among children with asthma using metered dose or dry powder inhalers. Journal of Asthma 2015;52:838-45.


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