

Physician-targeted program on inhaled therapy for childhood asthma

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Background: Inhaled medications are the mainstay of asthma therapy, but significant deficiencies exist in the knowledge and skills of physicians regarding use of metered-dose inhalers (MDI) and spacer devices.

Objective: We developed, implemented, and evaluated the effects of a physician-targeted educational program on inhaled therapy in a group of pediatric residents in our institution.

Methods: Patient-directed instruction sheets on aerosol therapy were developed on the basis of literature review and expert guidelines. These served to establish a consistent foundation for the educational curriculum. The program was delivered through one-on-two teaching sessions (45 minutes). Residents were provided with a summary of theoretical and practical information and with devices for practice (a placebo MDI, InspirEase and AeroChamber holding chambers, and the AeroChamber device with mask). Each session included review of an educational monograph, demonstration of proper technique, and practice with the different devices. The program was evaluated by a randomized-control design. Assessment of practical skills included number of correct steps for the use of MDI (maximum score, 7), InspirEase (maximum, 7) and AeroChamber (maximum, 6). Theoretical knowledge was assessed with 25 multiple-choice questions.

Results: Pretest scores in the experimental group (n = 24) were 3.7 of 7, 1.9 of 7, and 0.3 of 6 steps correct for MDI, InspirEase, and AeroChamber devices, respectively, and 13 of 25 for the theoretical knowledge assessment. The control group (n = 26) had similar pretest scores. After the program the experimental group significantly improved in all parameters: 6.3 of 7, 5.9 of 7, and 4.5 of 6 steps correct for MDI, InspirEase, and AeroChamber devices, respectively, and 18 of 25 questions correct (p < 0.01 for all parameters).

Conclusions: Implementation of a simple educational program among pediatric residents can significantly increase their skills in the use of inhalational therapy. (J ALLERGY CLIN IMMUNOL 1995;95:818-23.)

Key words: Asthma, asthma education, inhaled therapy, metered-dose inhaler

Inhaled medications delivered by metered-dose inhalers (MDI) with or without a spacer are the mainstay of asthma therapy. Despite the wide use of these medications, between 50% and 80% of patients with asthma do not benefit from them because of incorrect inhalation technique.¹⁻⁷ This is often associated with the failure of physicians to demonstrate proper inhaler technique to their

Abbreviation used

MDI: Metered-dose inhaler

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patients, to review it regularly, and to recognize the importance of patient education in asthma management.^{8,9} One cause cited for these deficiencies is inadequate proficiency regarding inhaler technique among the physicians who prescribe these medications.¹⁰⁻¹² We have recently studied pediatric residents and found that inadequacies regarding inhaled medications spanned not only practical skills but also the theoretical base for their use.¹³ These inadequacies were significantly greater regarding the use of holding chambers, a major breakthrough in improving drug delivery, particu-

larly in children. The results of this and another recent study¹⁴ indicate an important need for an educational program to increase the skills of pediatricians in the use of inhaled medications. The major objective of the present study was therefore to develop, implement, and evaluate the effects of such an educational program on a group of pediatric residents in our institution.

METHODS

Program content and delivery

Patient instruction sheets on the use of MDI and spacer devices were devised on the basis of a consensus view of how to use inhaled medications and a review of the literature.¹⁵⁻²¹ The consensus was developed by asthma experts from the pulmonary, allergy, and respiratory therapy divisions. These sheets were distributed to all units in the hospital involved in delivering asthma care.

The theoretical basis for these instructions, together with physician guidelines about selection of these devices, were outlined in an instructional monograph containing chapters addressing the following: (1) aerosol characteristics (i.e., variables that influence drug deposition in the airway, such as particle size and respiratory variables, and their effects on inhalation technique); (2) common methods of aerosol delivery (i.e., nebulizer, MDI, and MDI with holding chambers), a description of their operation, and a listing of their advantages and disadvantages; (3) factors to consider in selecting the mode of delivery (i.e., nebulizer vs MDI with or without spacer) such as choice of drug, age (e.g., infants and toddlers, and preschool-aged and school-aged patients), compliance, convenience, disease state, and socioeconomic status; (4) practical guidelines on how to select the appropriate mode of delivery for individual patients and how to instruct patients in the correct use of the inhaler devices; and (5) patient instruction sheets for individual devices.

Besides the instructional monograph, each resident in the educational program received samples of delivery systems. Samples consisted of one placebo MDI (Glaxo Inc., Research Triangle Park, N.C.) and three holding chambers (InspirEase, Key Pharmaceuticals Inc., Miami, Fla., AeroChamber device and AeroChamber device with mask (Monaghan Medical Corp., Plattisburgh, N.Y.), which were selected because of their common use within our institution. All devices were packed into a durable bag to facilitate their utility during the course of the study.

Small group sessions during the residents' rotations in the emergency department were used to deliver the instructional program on aerosols. The chief residents helped by arranging the list of residents and the timetable for the educational sessions so as not to interfere with the residents' clinical duties. A team of 10 physicians, respiratory therapists, and nurses (all specialists in

respiratory diseases) served as instructors for these sessions. Before initiation of the study, they were instructed as to the purpose, content, and format of the educational sessions. Each educational session lasted 40 minutes to 1 hour. Each instructor met with two residents. At the beginning of each session the residents were given the booklet and bag containing the different devices. The instructor then taught the correct techniques for the inhaler and the holding chambers, and reviewed the topics included in the booklet. The residents were encouraged to use the devices for teaching patients. The format was informal, flexible, and directed toward positive reinforcement of residents' skills. It allowed ample time to answer questions raised by the residents.

Program evaluation

To evaluate the program, we applied a randomized controlled design with preprogram and postprogram evaluation.

Pediatric residents in our institution from all 3 years of training were eligible to participate in the present study. The only exclusionary criterion was participation in the knowledge assessment study conducted in the previous year.¹³ Residents in the present study were initially interviewed to determine their baseline knowledge and skill level. The pretest interview consisted of a practical assessment and a written evaluation of theoretical knowledge.

For the assessment of practical knowledge each resident was given an unassembled placebo MDI and two unassembled spacer devices (InspirEase and AeroChamber with mask). The resident was then asked to demonstrate in a step-by-step fashion the exact assembly and use of the three devices (MDI and two spacers). Performance of seven steps (six for the AeroChamber with mask) that are fundamental to effective technique were assessed (Table I).¹⁵⁻²¹

The residents were asked to provide personal data regarding their experience in prescribing MDI and spacer devices in the management of asthma. They then answered 25 multiple-choice questions addressing the theory behind the practical aspects of MDI and spacer use (Table II).¹⁵⁻²¹ (The questionnaire is available from us on request.) All questionnaires were completed anonymously. Immediately after completion of this first pre-intervention interview, all the residents received constructive feedback to address the specific individual deficiencies in practical use of tested devices. This instruction session lasted only 5 minutes.

The residents were then randomly assigned with the aid of a random number table into two groups. The experimental group received the educational program described previously, whereas the control group received no further education regarding inhaled medications. The postintervention evaluation was performed 2 to 3 months after the educational sessions. Once the process was begun, all postintervention interviews were com-

TABLE I. Assessment of correct uses of MDI and spacer devices**MDI**

1. Correct assembly of parts
2. Shaking of inhaler before its use
3. Slow exhalation of tidal volume
4. Correct positioning of MDI at mouth (either with lips sealed around mouthpiece or with mouth open with canister held 1-2 inches away)
5. Activation immediately after initiation of inhalation
6. Slow, deep inhalation
7. Breath holding for 6-10 sec

Spacer devices

1. Correct assembly of spacer and MDI
2. Shaking of MDI before its use
3. Correct positioning of spacer in mouth
4. Proper exhalation before its use (for InspirEase)
5. Activation of MDI and initiation of inhalation within recommended time
6. Slow inhalation
7. Correct No. of activations and breaths for each device (1 depression of MDI followed by 2 sets of slow inhalations with InspirEase, and 4-6 regular tidal breaths per activation with Aero-Chamber with mask)

pleted within 1 month. They were conducted in the same manner as the preintervention interview. At the end the residents in the experimental group were asked to give their comments and suggestions regarding the program.

Preintervention scores were used to ensure that both groups were equivalent, and the effects of the program were assessed by comparing the postintervention evaluations of the two groups. No attempt was made to prevent contact between groups after the preintervention evaluation. Although the procedures used in our study design carry the risk of contamination, it should produce a conservative bias by reducing differences in study outcomes between experimental and control groups.

Statistical analysis

From each resident's evaluation the following scores were obtained: number of correct answers to the questionnaire (maximum, 25), and number of correct steps demonstrated in use of MDI (maximum, seven), InspirEase (maximum, seven), and AeroChamber devices (maximum, six). Statistical analyses included calculation of means and SD of the experimental and control groups scores, both before- and after-intervention. Comparisons were made by Student's *t* test and analysis of variance for repeated measurements. From the mean and variance data measured with the same instruments in our previous study,¹³ we calculated that, with use of a two-tailed test ($\alpha = 0.05$) with 20 subjects in each group, the power of the study was more than 80%.

TABLE II. Topics assessed in questionnaire

1. Ideal method for patient instruction
2. Importance of reinforcement of correct technique
3. Advantage of spacers in children
4. Importance of regular assessment of patient technique
5. Main factor limiting MDI use in children
6. Duration of metered spray
7. Purpose of shaking MDI before use
8. Usual recommended MDI dose
9. MDI positioning
10. Recommended age for MDI use
11. Side effects of medications administered by MDI
12. Timing of inhalation after activation of spacers
13. Activation/inhalation maneuver for spacers
14. Prevention of oral thrush by spacers
15. Breath-holding period with MDI
16. Purpose of slow inhalation
17. Purpose of breath holding
18. Exhalation before activation of MDI
19. Reduction of systemic drug absorption with use of spacers
20. Inspiratory maneuver with MDI
21. Assessment of remaining content in MDI
22. Proportion of medication that reaches lung parenchyma
23. Average time required for patient instruction of MDI
24. Relative difference in particle size of MDI versus spacers
25. Patient age at initiation of spacer devices

RESULTS**Participants**

A total of 54 residents entered the study. Twenty (37%) were in their first year of training, 18 (33%) were in their second year, and 16 (30%) were in their third year. Twenty-eight of these residents were assigned to the control group, and 26 to the experimental group. Two residents in the control group and two residents in the experimental group did not complete their postintervention evaluation and thus were excluded from the analysis.

Comparisons between study groups regarding gender, year of training, exposure to patients with asthma, past prescription of MDI or spacers, and past teaching of MDI or spacer technique yielded no statistically significant difference.

Evaluation

Results for the 50 residents who completed both preintervention and postintervention parts of the

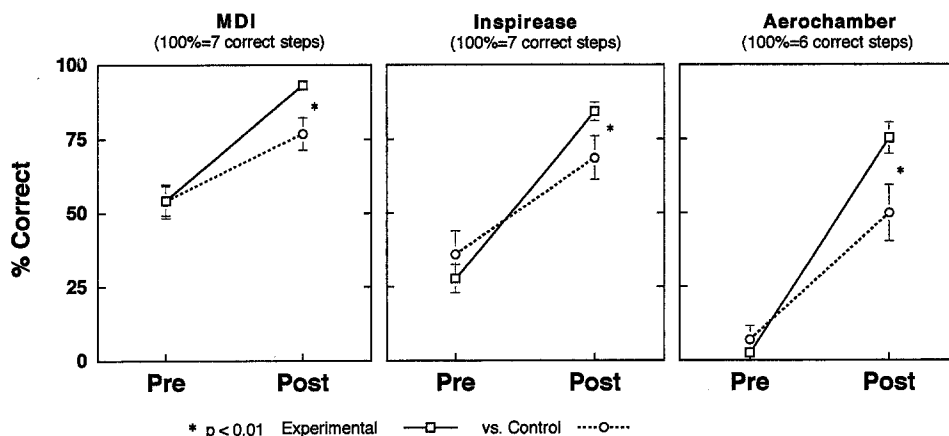


FIG. 1. Scores (mean $\pm$ SD) of correct steps in practical assessment for two groups before and after intervention.

evaluation are presented in Fig. 1 (practical skills) and Fig. 2 (theoretical knowledge). Pretest scores in the experimental group were 3.7 of 7, 1.9 of 7, and 0.3 of 6 steps correct for MDI, InspirEase, and AeroChamber devices, respectively, and 13 of 25 correct for the theoretical knowledge assessment. There was no difference in the preintervention scores between the experimental and the control group with respect to the practical skills or the theoretical knowledge. The elapsed time (mean $\pm$ SD) between the preintervention and postintervention evaluations was 82 ± 19 days for the control group and 71 ± 26 days for the experimental group not ($p =$ not significant). After the program the experimental group significantly improved in all parameters: 6.3 of 7, 5.9 of 7, and 4.5 of 6 steps correct for MDI, InspirEase, and AeroChamber devices, respectively, and 18 of 25 questions correct ($p < 0.01$ for all parameters). These scores were significantly higher than the scores obtained by the control group at the same time. The gains in practical skills (Fig. 1) were greater than the gains in theoretical knowledge (Fig. 2). Compared with the preintervention results, both experimental and control groups had significantly higher postintervention scores in all indices.

All the residents in the experimental group reported that they found the educational sessions to be very useful. The devices that they were provided also proved helpful, mostly in teaching their patients. Some residents used it mainly for personal practice. Most of the residents reported they had not read the entire booklet. All rated the program as very important to their training and reported an increase in their confidence and understanding of inhalational therapy. All but one

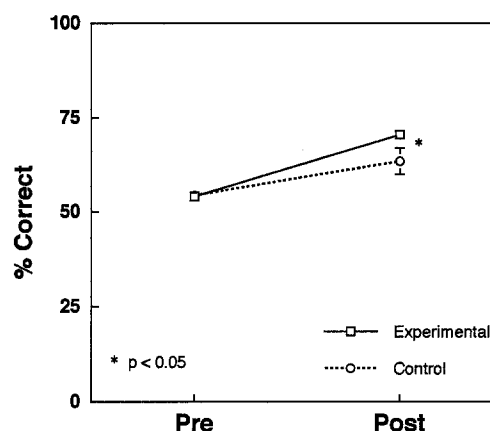


FIG. 2. Scores (mean $\pm$ SD) of correct steps in theoretical knowledge assessment for two groups before and after intervention.

resident reported that their practice regarding use of inhaled medications had changed after the intervention. Among the changes described were an increased number of prescriptions for inhaled medications compared with oral medications, an increased number of prescriptions for holding chamber and spacer devices compared with nebulizers, and more patient education regarding inhaled medications.

DISCUSSION

General pediatricians care for the majority of children with asthma,²² but they receive minimal training to prepare them optimally to manage asthma as comprehensively as recently has been recommended. As a result, many children with asthma may not receive optimal asthma care.²³ Both the medical community^{9, 24-28} and the public

media²⁹ have raised concerns that these inadequacies in asthma care contribute in part to the alarming increase in the morbidity and mortality from asthma. Given the importance of inhalational therapy in the management of asthma²¹ and documented inadequacies in the knowledge base of physicians regarding this modality,^{10-14, 30} educational programs aimed at increasing the skills of physicians in the use of inhalational therapy are needed. The results of the present randomized, controlled study suggest that implementation of a simple educational program among pediatric residents can significantly increase their skills in the use of inhalational therapy.

The intervention or teaching session itself took about 1 hour of each resident's time. The institution where the intervention took place is a university teaching hospital similar in many respects to many other institutions with a pediatric training program. We believe that this model could be easily modified and implemented in other training programs.

The randomized controlled design used in this study controls for the effects of "maturation." It takes into account that residents gain experience with asthma during their training, thus picking up information simply with the passage of time. Some of the increases observed in both study groups may have been related to such a maturational effect. It would have been much more difficult to differentiate this effect after a longer period than the one used in our relatively short-term study. Nevertheless, further studies may be needed to assess better the long-term influence of the program on the residents' skills. The improvement in the scores of the control group may also be attributed to the short informative session provided to that group after the pretest evaluation. It is important to note that no attempt was made to avoid "contamination" between the groups. It is probable that a major part of the improvement observed in the control group resulted from indirect influences of the educational programs. These influences could have occurred during any of the rotations where residents of both groups were mixed. In particular, such indirect educational effects could have occurred during encounters with patients with asthma in the emergency room, the continuous-care clinic, or the inpatient wards, or during asthma educational activities. Still, there was a significant difference between the posttest scores of the groups, proving the effectiveness of the program beyond mere clinical exposure and/or contamination effects. Because medical education cannot be completely isolated and because con-

tamination may even be "crucial to the process of learning and acting on one's knowledge,"³¹ the results of this study further strengthen the merit of implementing such a program in other institutions.

The goals of the program were to increase both theoretical and practical skills of residents regarding inhaled therapy. Regarding the practical skills, the educational program achieved its goals for both MDI and spacers. The improvement was more pronounced in the spacers than in the MDI. One possible explanation is that the MDI is inherently more complex to operate correctly than spacers both in children and adults. The importance of our findings with respect to teaching the use of spacers should not be underestimated. Spacers have become an important adjuvant in inhaled therapy for asthma, especially in children. Pediatricians should be familiar with their use. The results confirm a previous report that pediatricians have significantly more inadequacies with the use of spacers than with MDI.¹³ The present program would therefore meet an important educational need.

Although the practical skills of the residents markedly improved, the effects of the program on the theoretical knowledge were less impressive. One possible explanation for this is that the questionnaire used to assess theoretical knowledge is not sensitive enough to these changes. Further studies would be required, to evaluate the validity of the questionnaire in the assessment of the educational intervention. A more likely explanation is that most of the theoretical curriculum was contained in the monograph and was reviewed only briefly during the individual sessions. These sessions were mostly devoted to teaching the practical skills. Most of the residents admitted to having not read the monograph. When questioned why, most replied that they had no time. We are now in the process of adjusting this booklet into a shorter and more user-friendly format.

In conclusion, implementation of a simple educational program increased proficiency of pediatric residents in the use of inhaled therapy. Further studies to assess directly the impact of physician-targeted educational programs about inhaled therapy on patients' outcomes will be of interest.

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