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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

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ORIGINAL ARTICLE

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

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Background. While initial education and regular evaluation of inhaler technique in patients are emphasized in the management of asthma and chronic obstructive pulmonary disease, health care professionals are not experienced in using inhalers. This study assessed whether internal medicine residents used common inhalers correctly and whether a single teaching session successfully improved their performance. **Methods.** We evaluated 142 internal medicine residents from six university hospitals in Korea for their techniques with three different inhaler devices: a metered dose inhaler (MDI), Diskus, and Turbuhaler. We assessed whether participants completed each step in using the three inhalers and classified overall performance as good, adequate, or inadequate for each inhaler type. To estimate the effect of a single teaching session, reassessment was performed 2 months after education. **Results.** Performance grade was inadequate for 50.7% of participants with a MDI, 43.0% for Diskus, and 51.4% for Turbuhaler. An early year of residency was associated significantly with inappropriate technique for Diskus ($p = 0.003$), but not for MDI and Turbuhaler. After a single teaching session, overall skills improved significantly for all three inhalers. The proportion of subjects with good or adequate skill changed notably from 39.7% to 83.8% for MDI ($p = 0.001$), from 50.0% to 86.8% for Diskus ($p = 0.001$), and from 44.1% to 88.2% for Turbuhaler ($p = 0.001$). **Conclusions.** These findings demonstrate that a high proportion of internal medicine residents cannot use inhalers correctly and just a single teaching can effectively enhance their inhaler technique.

Keywords asthma; chronic obstructive pulmonary disease; Diskus; internal medicine; metered dose inhaler; residents; Turbuhaler

INTRODUCTION

In the pharmacological treatment of chronic airway diseases such as asthma and chronic obstructive pulmonary disease (COPD), inhaled medication is preferred to systemic medication because it has rapid onset of action and is effective in the management of disease, with significant reduction in systemic side effects (1, 2). International guidelines for asthma and COPD recommend that physicians prescribe inhalational medication when available. Therefore, the correct use of inhaler devices is essential in the management of asthma and evaluating whether they are using their inhalers correctly on a regular basis is necessary (3). For proper education and supervision of patients who use inhaler devices, physicians should be familiar with various kinds of inhaler devices and be able to use these in a proper manner (4).

Previous studies have shown that many physicians have poor inhaler skills, with lower scores compared to those of respiratory therapists (5–7). Chest physicians and allergists showed better scores for inhaler use than general

practitioners involved in respiratory patient care (8). These findings emphasize the importance of educating residents in training in the correct use of inhaler devices. However, previous studies among internal medicine residents have shown that they lack the correct skills in the use of inhalers (5, 9–13).

In this multicenter study, we evaluated internal medicine residents from six university hospitals for their techniques with the three most frequently used inhaler devices. This is believed to be the first such study in Korea. Common errors were identified in using each type of inhaler and factors associated with inadequate inhaler technique were identified. Next, we examined whether a single instruction session for inhaler techniques improved the residents' performance.

METHODS

Study Design and Subjects

This multicenter study was performed at six university hospitals in Korea: three in Seoul (Hanyang University Hospital, Asan Medical Center, and Seoul National University Hospital); one in Goyang, a satellite city of Seoul (Inje University Ilsan Paik Hospital); one in Incheon, a large city on the western coast (Inha University Hospital); and one in Cheonan,

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TABLE 1.—Characteristics of the subjects.

Characteristics	Subjects (n = 142)
Male (%)	84 (59.2)
Age (years)*	29.1 ± 2.4
Residency location	
Seoul (%)	107 (75.4)
Incheon (%)	13 (9.2)
Goyang (%)	11 (7.7)
Cheonan (%)	11 (7.7)
Year of residency	
1 (%)	58 (40.8)
2 (%)	46 (32.4)
3 (%)	34 (23.9)
4 (%)	4 (2.8)

*Mean ± SD.

a southwestern city in the Korean Peninsula (Dankook University Hospital). All these hospitals are tertiary care centers and teaching affiliates of medical schools for the specialty of respiratory medicine and allergy. Internal medicine residents in years 1 to 4 of their residency at the participant hospitals were asked individually to participate in the study on the first evaluation date. All the residents were blind to the study design before the time of enrollment to rule out possible effects of self-education or training by others. All of the requested residents agreed to participate in this study, and a total of 142 internal medicine residents from six hospitals enrolled (Table 1). According to the general training programs in Korea, internal medicine residents had finished their 1-year internship in general medicine before beginning their residency in internal medicine. About three-quarters of subjects were in their first or second residency year. Baseline evaluation in each hospital was performed on 1 day between November 2007 and February 2008, and the date differed depending on the hospital. A single teaching session on inhaler technique was delivered to all the participants just after the first evaluation. Two months after teaching, a further evaluation was conducted to examine the effect of the teaching, without previous notice. The present study was approved by the institutional review board of each participating hospital.

Evaluation of Inhaler Technique

We selected three devices for evaluation: a metered dose inhaler (MDI) that contained salbutamol (Ventolin®; GlaxoSmithKline Korea), Diskus, which contained fluticasone/salmeterol (Seretide®; GlaxoSmithKline Korea), and Turbuhaler, which contained budesonide/formoterol (Symbicort®; AstraZeneca). These devices were chosen because they are most commonly used at present in patients with asthma and COPD in Korea. The interview and evaluation of the technique was performed by one of the attending physicians, who was an allergy specialist at each hospital, and the authors of this study. Each resident was asked to demonstrate how to use the three inhaler devices consecutively in front of an examiner, without observation by the other participants. To assess which operating step was performed poorly, we set several steps for each inhaler (Table 2). For example, the correct use of the MDI was composed of five steps: (1) shake and hold the device properly, (2) exhale to residual volume slowly, (3) coordinate hand movement and inhalation, (4) inhale

TABLE 2.—Steps of inhaler use.

Devices	Steps
MDI	1. Shake, remove cap, and hold device properly. 2. Exhale to residual volume slowly. 3. Coordinate hand movement and inhalation. 4. Inhale slowly and deeply. 5. Hold breath for 5–10 s.
Diskus	1. Open and hold device properly. 2. Load and prime device. 3. Exhale to residual volume slowly. 4. Inhale forcefully and deeply. 5. Hold breath for 5–10 s. 6. Rinse mouth.
Turbuhaler	1. Open and hold device properly. 2. Load and prime device. 3. Exhale to residual volume slowly. 4. Inhale forcefully and deeply. 5. Hold breath for 5–10 s. 6. Rinse mouth.

slowly and deeply, and (5) hold one's breath for 5 to 10 seconds. Since Diskus and Turbuhaler used in the current study contained corticosteroid, we added another step for these inhalers: Rinse one's mouth to wash out powder. The examiners checked if the participant performed each step for the inhalers. In addition, overall technique for each inhaler was classified into three grades: good, adequate, and inadequate based on levels of accomplishment of the defined steps. A participant was given a grade of good if he or she performed every step without exception. When a participant performed key steps, including coordinate hand movement and inhalation, load and prime device, and inhale forcefully and deeply, but did not complete all the required steps, a grade of adequate was given. Those who failed any one of the key steps were graded as inadequate.

Effect of a Single Instruction Session on Inhaler Techniques

After baseline evaluation of current inhaler technique, we examined if a single instruction session was effective at enhancing inhaler technique in internal medicine residents. Just after the first assessment of inhaler technique, a lecture was delivered by the examiner to all the participants on how to use inhaler devices appropriately. The lecture lasted 30 to 40 minutes and included a demonstration of inhaler use by the instructor. Two months later, we assessed the participants again using the same method as before. Like the baseline evaluation, no notice of reexamination was given before the second interview to reduce effect of further self-training in inhaler skills. Among the 142 residents who were enrolled at the first evaluation, 74 were not evaluated for the second time because they were not on duty or were working in other hospitals at the time of assessment. Therefore, the remaining 68 residents (47.9%) were assessed in the post-educational examination.

Statistical Analysis

At baseline, a comparison was made between the good or adequate group and the inadequate group for each inhaler using the χ^2 test for sex and residency year and Student's *t* test for age. We compared the proportion of subjects with a grade of inadequate technique before and after instruction using the χ^2 test. Likewise, the difference in the number of subjects who accomplished the steps before and after instruction was compared using the χ^2 test. All statistical analyses

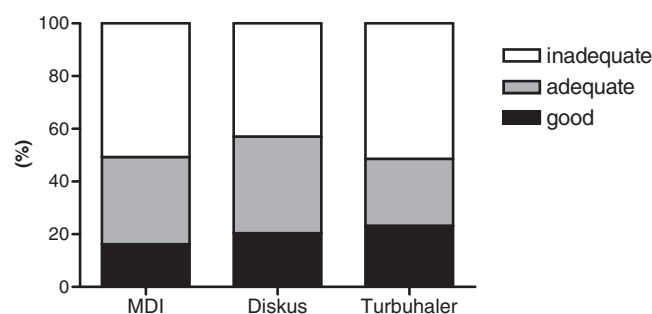


FIGURE 1.—Overall assessment of the technique of each inhaler at baseline. Each section of the bar indicates the percentage of subjects whose overall technique was determined as inadequate, adequate, or good.

were performed using SPSS version 17.0, and $p < 0.05$ was regarded as statistically significant.

RESULTS

Inhaler Technique in Internal Medicine Residents

In the overall assessment of inhaler technique, for MDI, 16.2% of the subjects were graded as good, with 33.1% as adequate and 50.7% as inadequate (Figure 1). Diskus and Turbuhaler showed a comparable proportion of good technique (20.4% and 23.2%, respectively), with 36.6% and 25.4%, respectively, as adequate and 43.0% and 51.4%, respectively, as inadequate. For the steps of MDI use, the success rate was 42.3% to 66.9% (Figure 2A). Only 42.3% of subjects performed the step of “exhale to residual volume slowly” correctly, which was the lowest score among the steps. Use of dry powder inhalers (Diskus and Turbuhaler) was composed of six required steps. Although the success rate varied from 40.8% to 93.7% for Diskus (Figure 2B), only the first step, “open and hold device properly,” showed a very high success rate (93.7%), and the other steps ranged from 40.8% to 64.1%. The evaluation of Turbuhaler use demonstrated similar patterns of accomplishment rate as Diskus (Figure 2C), with the highest proportion in the first step (90.1%) and the lowest in the step “exhale to residual volume slowly” (37.3%).

Factors Associated with Inadequate Inhaler Technique

We explored the factors associated with inadequate technique for the use of MDI, Diskus, and Turbuhaler. Comparisons were made between subjects with good or adequate technique and those with inadequate technique. Sex and age were not significantly different between the groups for all three inhalers (Table 3). Regarding residency year, a

significant difference was found for Diskus. For those in their first year of residency, the proportion with inadequate performance was higher than those with good or adequate performance (55.7% vs. 29.6%, $p = 0.003$). However, residency year had no significant effect on performance for MDI or Turbuhaler.

Effects of a Single Instruction Session on Correct Inhaler Use

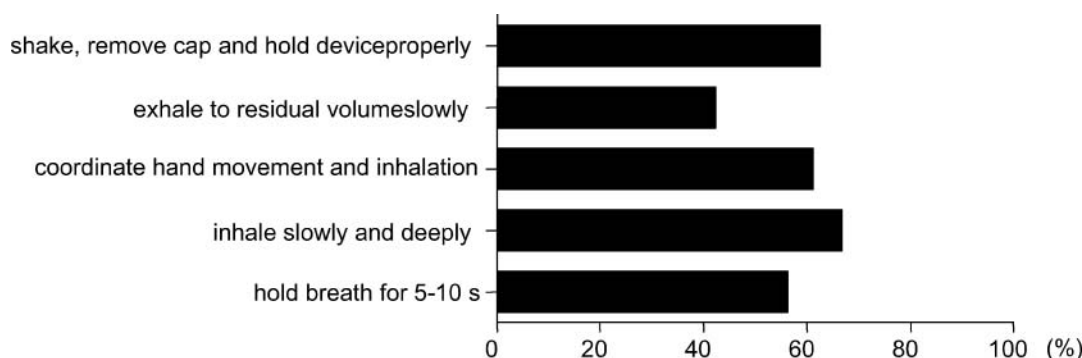
We evaluated if a single teaching session for correct inhaler use enhanced the skills of internal medicine residents. For the overall technique of MDI, the proportion of subjects with good or adequate skill changed notably from 39.7% to 83.8% ($p = 0.001$) (Figure 3). Significant changes were also found for Diskus (50.0% to 86.8%, $p = 0.001$) and Turbuhaler (44.1% to 88.2%, $p = 0.001$). The accomplishment rate for each step of the inhaler procedure also changed significantly. For MDI, an increase was observed in the success rate for every step after instruction, which ranged from 61.8% to 92.6% (Figure 4A). The step “exhale to residual volume slowly” still showed the lowest success rate, as in the first assessment. Also for Diskus, an increase occurred in the success rate for every step except step 1, with significant changes in the following four previously low-estimated steps. In particular, the proportion who accomplished the step “inhale forcefully and deeply” nearly doubled after instruction, from 50.0% to 91.2%. For Turbuhaler, all of the steps showed a significant increase in the accomplishment rate, except for step 1, which was performed well before instruction.

DISCUSSION

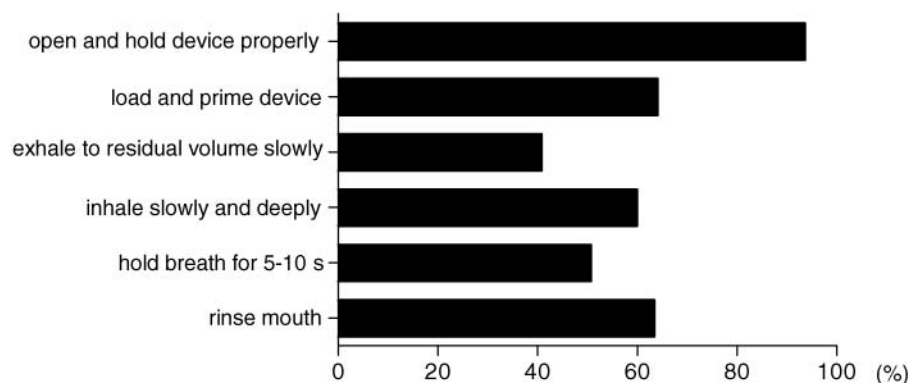
Patient education in inhaler use is mandatory for effective treatment and long-term control of asthma and COPD (14). Although guidelines emphasize the importance of routine instruction in inhaler use by physicians and regular assessment of their competence, a considerable gap exists between patient and physician conception of regular discussion on inhaler technique. Most physicians estimated that they spared sufficient time for discussing correct inhaler technique, although patients did not share this view (15). Moreover, many health care professionals, including physicians, pharmacists, nurses, and respiratory therapists, are lacking in knowledge on the correct use of MDIs and dry-powder inhalers (7). Of the various health care professionals, residents involved in respiratory care should be experienced in inhaler use because many patients start inhalation medication after visiting an emergency department or after hospital admission for acute exacerbation of asthma or COPD. However, previous studies have found poor performance in the use of inhalers

TABLE 3.—Factors associated with inadequate inhaler technique.

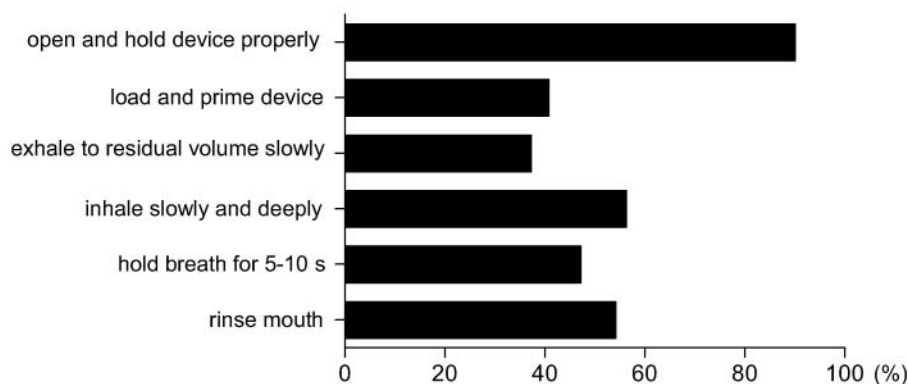
	MDI			Diskus			Turbuhaler		
	Good or adequate (n = 70)	Inadequate (n = 72)	p value	Good or adequate (n = 81)	Inadequate (n = 61)	p value	Good or adequate (n = 70)	Inadequate (n = 72)	p value
Male sex (%)	38 (54.3)	46 (63.9)	NS	47 (58.0)	37 (60.7)	NS	40 (57.1)	44 (61.1)	NS
Age (mean $\pm$ SD)	28.8 $\pm$ 2.3	29.4 $\pm$ 2.4	NS	29.3 $\pm$ 2.2	28.9 $\pm$ 2.6	NS	29.0 $\pm$ 2.2	29.2 $\pm$ 2.5	NS
Residency year			NS			0.003			NS
1 (%)	25 (35.7)	33 (45.8)		24 (29.6)	34 (55.7)		27 (38.6)	31 (43.1)	
2 (%)	24 (34.3)	22 (30.6)		28 (34.6)	18 (29.5)		23 (32.9)	23 (31.9)	
3–4 (%)	21 (30.0)	17 (23.6)		29 (35.8)	9 (14.8)		20 (28.6)	18 (25.0)	



(A)



(B)



(C)

FIGURE 2.—Proportion of subjects who accomplished each step of inhaler use at baseline. (A) MDI; (B) Diskus; (C) Turbuhaler. The bars indicate the percentage of subjects who accomplished the corresponding steps.

among residents in internal medicine (9–13), pediatrics (16, 17), and emergency medicine (18).

In our evaluation of inhaler performance in internal medicine residents, we assessed inhaler skills for three types of inhalers that are currently used most commonly in Korea. In designing the current study, we anticipated that nearly all residents would show good performance with inhalers because the majority of them have experienced patients with asthma and COPD. Although many patients are still not using

inhalers in Korea (19), nearly all of those who visit university hospitals for asthma and COPD are prescribed and managed with inhalation medication by a specialist in allergy and respiratory medicine. Contrary to our expectation, a high percentage of internal medicine residents from university hospitals in Korea were not able to use the MDI, Diskus, and Turbuhaler inhalers correctly. Less than 25% of the participants showed good performance and about 50% were graded as inadequate. The overall assessment was similar for the three

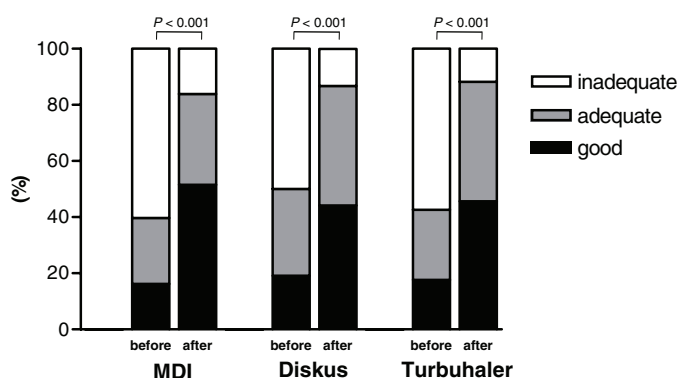


FIGURE 3.—Overall assessment of the technique of each inhaler before and after instruction. Each section of the bar indicates the percentage of subjects whose overall technique was determined as inadequate, adequate, or good. * $p < 0.05$ compared to value before instruction.

kinds of inhalers. For all the inhalers, the most common error was the step “exhale to residual volume slowly.” This finding is consistent with the previous studies in that the most frequent error in using MDI and dry powder inhalers was no exhalation before inhalation both in patients and health care professionals (20, 21). For proper delivery of drugs to target sites by inhalation, one should prepare for inhalation by exhaling air in the lung to the residual volume slowly and gently. Failure in this step might cause suboptimal drug delivery and decreased response. Previous studies support the need to exhale to residual volume slowly before inhalation (21). Contrary to the excellent results with dry-powder inhalers (Diskus and Turbuhaler), the first step, “shake and hold device properly” was failed by about one-third of the participants with the MDI. The success rate in opening and holding the MDI was lower compared to that in previous studies in physicians (8) and residents (10). This suggests the need for special attention for this step during education in the techniques for MDI use. We selected some steps as key steps in evaluating inhaler technique (“coordinate hand and inhalation,” “load and prime device,” and “inhale forcefully and deeply”) because failure in these processes can lead to nondelivery of medication (11, 22, 23). The success rate in the key steps ranged from 44.8% to 66.9%, which affected the performance grade in general.

In the analysis of factors related to inhaler technique, we found that early year of residency was associated significantly with inadequate performance for Diskus. This was comparable to the study by Mas et al, who reported that more errors in MDI use were found in postgraduate year 1 than year 3 residents (24). However, we found a discrepancy in the association with residency year for all three inhalers in that a positive association was demonstrated only for Diskus and not for the MDI or Turbuhaler. Why this inconsistency between the inhaler types? We speculate that experience with or exposure to the specific inhaler type is important in an individual's performance with a given inhaler. While interns and internal medicine residents are involved in acute care of respiratory diseases early in their training period, they usually see outpatients and prescribe long-term control later in their residency. Consequently, residents in their first year seem

more familiar with the use of MDIs, which are often used for delivering rescue medication (such as salbutamol or ipratropium) for asthma and COPD, although they do not know how to use MDIs correctly. Since Diskus and Turbuhaler are often used for delivery of long-term medication, such as corticosteroids and/or long-acting bronchodilators, first-year residents might have had no prior opportunity to prescribe Diskus or Turbuhaler. As with years in residency, internal medicine residents can have more experience with Diskus and Turbuhaler. This may explain why residents in years 3 to 4 showed more competent performance with Diskus. Nevertheless, this correlation of proficiency with residency year was not found for Turbuhaler in the current study. One may speculate that residents had less exposure to Turbuhaler because it is prescribed less frequently (1 to 3 times) than Diskus at present in Korea.

Among the reasons for improper inhaler techniques in physicians as well as patients, the lack of an educational program on their use is the main explanation. The effect of an educational program on physicians in training was examined in first-year medical interns (25), pediatric residents (26), internal medicine residents (27), and fourth-year medical students (28). In terms of educational methods and content, various approaches were tried, from a single lecture to intensive and organized programs. In a study by Rebeck et al. in Canada, just one brief teaching session proved to be effective in bringing about sustained improvement in the techniques for MDIs and dry-powder inhalers among internal medicine residents over 8 months (25). In contrast, Lee-Wong and Mayo demonstrated that one-to-one teaching was superior to a large group lecture in improving performance with MDIs and spacers among medical interns (25). In the current study, we evaluated if a single lecture, not face-to-face instruction, improved inhaler skills. The post-educational evaluation 2 months later showed a significant increase in inhaler performance, although many residents were still not completely proficient at inhaler use. These findings are consistent with previous studies, in that only a single lecture is not sufficient in achieving complete inhaler techniques. In addition, a need exists for a comprehensive and continuing educational program on inhalers in the training courses for internal medicine.

A few limitations in the current study should be noted. First, inter- and intra-rater reliability in the assessment may be an issue because a participant's performance was evaluated by one examiner at each hospital (29). Moreover, the lecture was delivered by different instructors. Although all the examiners were specialists in allergy and respiratory medicine, the assessment and the lecture may have differed depending on the examiner. To reduce bias, we convened a workshop to form standard evaluation tools and educational content for designing the study. Second, a small number of residents in year 4 were enrolled in the study, and overall assessment reflected data from years 1 to 3 of residency. In addition, because all of the enrolled residents were working for university hospitals under the supervision of a specialist, the current study may have overestimated residents' abilities. Studies that include nonuniversity hospitals might reflect actual performance in internal medicine residents. Finally, we cannot determine how long the effect of education will last because we evaluated changes after 2 months. A repetitive

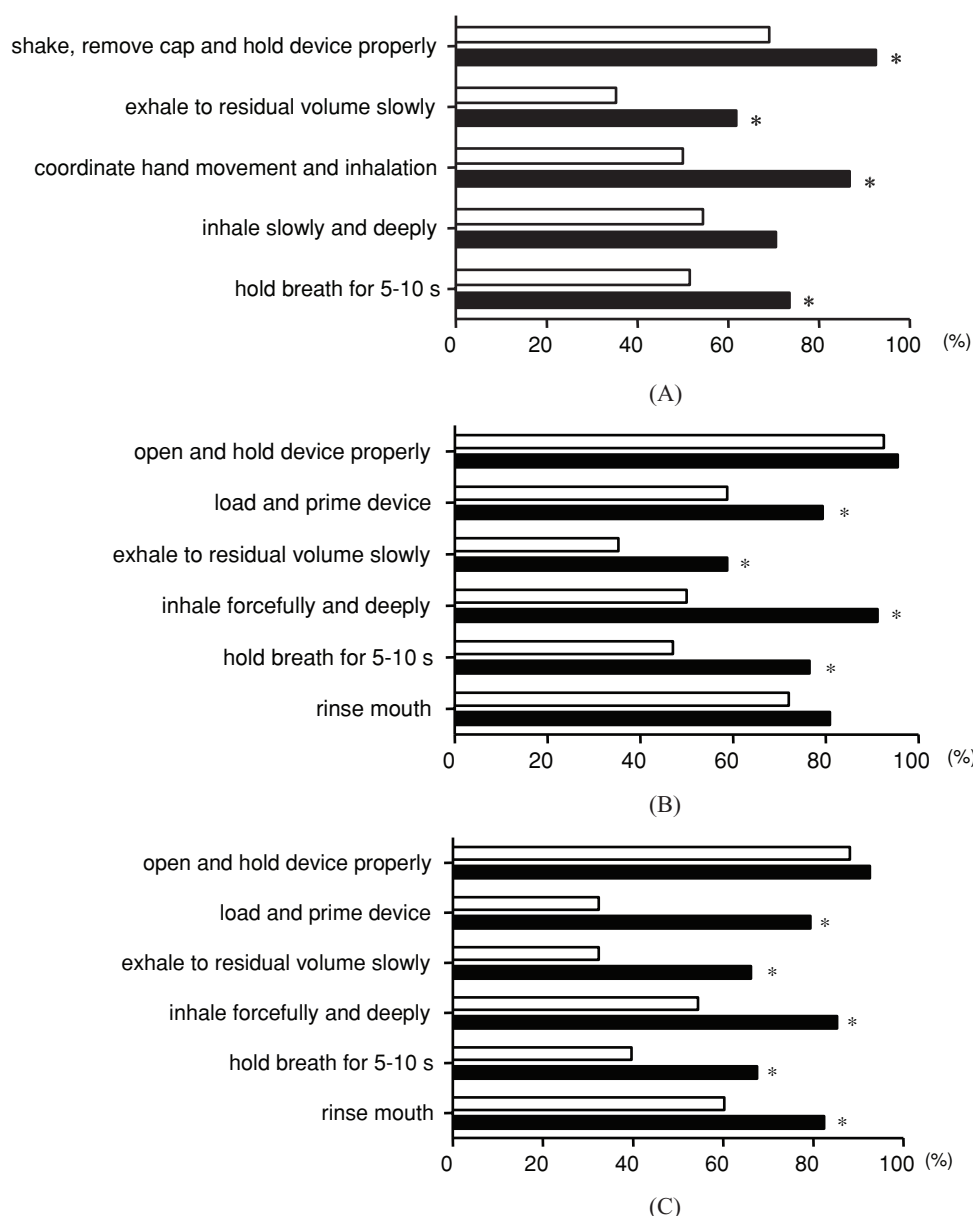


FIGURE 4.—The proportion of subjects who accomplished each step of inhaler use before and after instruction. (A) MDI; (B) Diskus; (C) Turbuhaler. The bars indicate the percentage of subjects who accomplished related steps before (empty bar) and after instruction (filled bar). * $p < 0.05$ compared to value before instruction.

teaching program might be needed to boost the educational effects.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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