

# Diverse Inhaler Devices: A Big Challenge for Health-Care Professionals

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**BACKGROUND:** The current variety of medication inhaler devices can be confusing to patients due to the many different delivery systems. Many health-care professionals who prescribe these devices may not be educated properly about the administration techniques for different inhalers. The objectives of this study were to evaluate various health-care providers' knowledge of specific inhaler devices and to assess their ability to retain this knowledge for a minimum period of 3 months. **METHODS:** This was a prospective study that included 4 different health-care professional groups (physicians, respiratory therapists, registered nurses, and pharmacists). All subjects underwent baseline written and practical tests. A checklist was developed for the practicum test for each inhaler on the correct delivery method. The written examination tested knowledge of 4 different inhaler techniques with true or false questions. Then subjects watched an instructional video that demonstrated the correct method of delivery for each device. Last, subjects were retested on the practicum and written tests after a minimum lapse of 3 months. **RESULTS:** The distribution of written and practical scores at baseline and postintervention was approximately normal ( $P > .05$ ). The baseline written scores were significantly different across groups ( $P = .002$ ). The mean written score of respiratory therapists was significantly higher than those of registered nurses and physicians ( $P = .02$  and  $.01$ , respectively). Similarly, the baseline practical scores were significantly different across groups ( $P < .001$ ). The mean practical score of respiratory therapists was significantly higher compared with those of registered nurses and physicians ( $P = .002$  and  $P < .001$ , respectively). **CONCLUSIONS:** We found a suboptimal number of medical professionals who have the proper knowledge base and technical skill to teach different inhaler device techniques. In order to increase the simplicity and effectiveness of delivering inhaler medication, we hope that the industry will provide more uniformity for future inhaler devices. *Key words:* MDI; education; inhaler techniques; DPI; inhalers; health-care professionals; physicians; respiratory therapist; pharmacists; registered nurses. [Respir Care 2016;61(5):593–599. © 2016 Daedalus Enterprises]

## Introduction

Current management guidelines for asthma and COPD emphasize the role of self-administered inhalation therapy

as the cornerstone for optimal long-term treatment.<sup>1</sup> Many patients with asthma and COPD have recurrent exacerbations or uncontrolled disease, one reason being poor adherence to use of the inhaler(s). Inhaler non-adherence may be due to many factors, such as inadequate matching

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of inhalers to patients' lifestyles, patients' limited physical capabilities to use the inhaler, or cultural and religious reasons discouraging inhaler use.<sup>2</sup> However, one of the most common reasons for incorrect inhaler use is related to difficulty or confusion regarding how to use the inhaler properly.

Current inhalers come in a multitude of unconventional designs with varying technical requirements for administration. These technical requirements and new designs make it difficult to teach patients the proper use of the devices.<sup>3</sup> Health-care professionals also have difficulties keeping up with the constantly changing designs and techniques for the different inhaler devices.<sup>4</sup> These difficulties are related to many factors, including memory and the pace of change over time.

Many health-care professionals who prescribe or administer inhaler devices may not be educated sufficiently with regard to the proper administration technique or the technical components of each device.<sup>4,6</sup> Most clinicians' inhaler education is based on learning device technique in school or at a one-time on-the-job training. In addition, these training sessions are not followed up with refresher courses that teach new techniques for newer devices. In a recent Year in Review article published in *RESPIRATORY CARE*, Myers<sup>7</sup> reported on the importance of repeated education and training for health-care practitioners on inhaler techniques. Furthermore, Melani<sup>8</sup> reported that health-care professionals have a key role in teaching proper inhaler techniques to their patients. Therefore, ensuring that health-care professionals have the requisite device knowledge should overcome this barrier and have a positive effect on patient adherence for each device.

Patient and health-care professional education topics on the use of inhaler devices have been studied and documented throughout the years.<sup>6,9,10</sup> However, there is still no valid solution for this problem. In their study, Tsang et al<sup>11</sup> studied surveys of 100 physicians, who were asked about the use of metered-dose inhalers. The survey was intended to test their knowledge and use of the device itself. Their procedure was divided into several steps: shaking the inhaler, full expiration, mouthpiece position, triggering, inspiration, and breath-holding. Subjects scored low in 2 steps in the knowledge section (breath-holding and triggering) with scores of 55 out of 100.

In another study, they studied community pharmacist to assess their skills and knowledge on several inhaler devices. Researchers concluded that the pharmacists lacked knowledge of how to actuate inhaler devices. Furthermore, the authors advised primary care physicians not to assume that pharmacists have a full understanding of all inhalers, especially new ones.<sup>12,13</sup>

Health-care professionals knowledge on the use of different inhaler devices were compared to patients knowledge as well.<sup>9,14</sup> Interiano and Guntupalli<sup>9</sup> studied internal medicine

## QUICK LOOK

### Current knowledge

The number of inhaled drugs given via metered-dose inhalers or dry powder inhalers has increased in recent years. Specialty devices have significantly different requirements for patient interaction to optimize drug delivery. Upon presentation to our pulmonary care clinic and our emergency department, we have observed that many patients have poor technique and may not be getting the medicine that has been prescribed. There are 4 different types of caregivers who instruct patients on how to use their inhalers.

### What this paper contributes to our knowledge

There are significant knowledge gaps among caregivers with regard to instructing patients in the use of these inhalers. Passive instruction, like watching a video or listening to an instructor, results in suboptimal performance and knowledge retention after follow-up.

physicians in postgraduate years ( $n = 100$ ), pulmonary fellows ( $n = 6$ ), respiratory therapists (RTs) ( $n = 20$ ), and nursing staff ( $n = 50$ ) and focused on demonstration and device technique only. The study organized the scoring system and performance for the practicum tests into 3 categories (good, fair, and poor). Among all groups, they found that the RT group scored the highest compared with the other professional groups. Nurses had a low percentage in device performance, where they only knew 2–3 steps out of 6. In the physician group, 43% fell into the good category. These results were consistent with the subject group where they showed a lack of understanding in how to use inhalers properly.

Companies are constantly introducing new inhalers requiring new techniques of administration. The different techniques can be so complicated that many patients may not be getting the medication that they need. Several studies looked at the differences between the available inhalation devices and compared their effectiveness in patients. These studies reported a trend of no significant difference in effectiveness among the tested devices.<sup>15-17</sup> However, other studies have shown that there is large variation in medication delivery for the different devices.<sup>6,18-20</sup>

A study by Larsen et al<sup>3</sup> concluded that two thirds of patients who are prescribed these devices did not have effective medication delivery. In addition, the different inhaler techniques may be too challenging for patients who are unable to coordinate the administration of the drug and have low dexterity. Hardwell et al<sup>21</sup> examined the effect of training of subjects with asthma in the use of a pressurized metered-dose inhaler. They assessed the delivery technique by using an aerosol inhalation monitor in addition to providing the

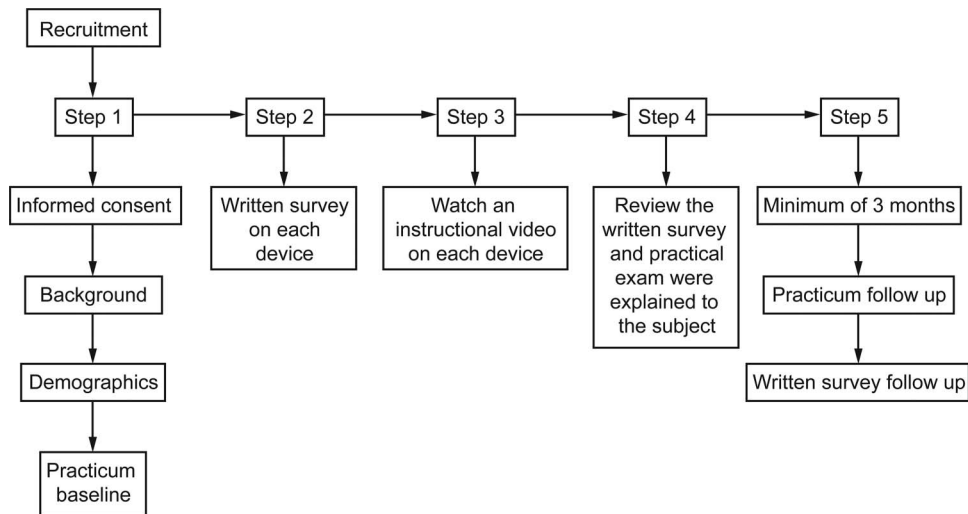


Fig. 1. Flow chart.

patients with an adequate educational setting. They found that even with the use of the educational settings and after using the aerosol inhalation monitor for assessment, subjects still struggled to use the pressurized metered-dose inhaler correctly. On the other hand, many patients did not receive the proper method of instruction on each prescribed device, and thus, poor inhalation technique was observed.<sup>15</sup>

The purpose of this study was to investigate and compare the knowledge retention of different health-care professionals about several different inhalation devices. The study included 4 different health-care professional groups consisting of RTs, pharmacists, registered nurses, and physicians. Our aim was to test the knowledge about different inhalers using written and practical tests. We included an intervention in the form of a video to show the correct procedure of administration for each of the inhalers. Subjects were then retested after a minimum waiting period of 3 months to assess their knowledge retention about the different inhalers. We hypothesized that all of the health-care providers tested would score 80–100% on the written and practical tests of each device. Subjects that fell below the optimal level (80–100%) of knowledge retention were expected to improve after watching the video.

### Methods

Subjects were recruited from Loma Linda University Health Services and were from one of the following 4 health-care professions: RTs, pharmacists, registered nurses, and physicians. The study was approved by the institutional review board at Loma Linda University. Subjects had to either regularly (at least once per month) prescribe inhalation devices or educate patients regarding the correct use of inhalation devices. Each subject participated in 2 assessments consisting of a baseline assessment and a follow-up. The baseline assessments included background and demographic informa-

tion. In the first step, the subject was given 4 different placebo inhalation devices. The devices were for tiotropium (Boehringer Ingelheim, Ridgefield, Connecticut) (dry powder inhaler, HandiHaler), fluticasone/salmeterol (Glaxo-Smith-Kline, Philadelphia, Pennsylvania) (Diskus), albuterol (Merck, Kenilworth, New Jersey) (metered-dose inhaler), and budesonide (Astra Zeneca, Wilmington, Delaware) (dry powder inhaler). The subjects were instructed to demonstrate the steps they would use if they were going to use the inhaler themselves. The research assistant observed the subjects and used a checklist to record how many steps the subject performed correctly. The steps in the practical examination were compiled from the instructional packets that were included in the packaging of each inhaler device. The instructional packets were written by the pharmaceutical companies that manufactured the devices and explained the correct use of each device.

In the second step, the subjects responded to a 5-question written survey about each inhaler device. The questions were about the proper use of each inhaler device and were formulated from the instruction manuals of each inhaler. There were no questions about pharmaceutical reagents or physiological mechanics of the prescription medication. In the third step, the subjects watched a video explaining the correct use of each inhaler device. The video was compiled from short (2–3-min) pharmaceutical instruction videos found on the corresponding company's website. In the fourth step, the answers to the survey and the practical examination were explained to the subjects. Finally, in the last step, a follow-up was done at least 3 months after the baseline measurements and included the same practical examination and written questionnaire as the baseline assessment (see Fig. 1).

## DIVERSE INHALER DEVICES: A CHALLENGE FOR HEALTH-CARE PROFESSIONALS

Table 1. Steps Used to Assess Demonstration Score for Each Inhaler

Inhalers	Steps
Advair Diskus	<ol style="list-style-type: none"> <li>1. Hold the Diskus in one hand, place the thumb of the other hand on the thumb grip, and push your thumb away from you as far as it will go until the mouthpiece appears and snaps into position.</li> <li>2. Hold the Diskus in a level, horizontal position with the mouthpiece toward you.</li> <li>3. Slide the lever away from you as far as it will go until it clicks.</li> <li>4. Before inhaling the dose, breathe out as far as is comfortable, holding the Diskus level and away from your mouth.</li> <li>5. Put the mouthpiece to your lips, and breathe in quickly and deeply through the Diskus (do not breathe in through your nose).</li> <li>6. Remove the Diskus from your mouth.</li> <li>7. Hold breath to comfort (5–10 s).</li> <li>8. Breathe out slowly.</li> <li>9. Close the Diskus when finished by placing your thumb on the thumb grip and sliding the thumb grip back toward you as far as it will go (until it clicks shut).</li> </ol>
ProAir HFA	<ol style="list-style-type: none"> <li>1. Take the cap off of the mouthpiece of the actuator.</li> <li>2. Shake the inhaler.</li> <li>3. Hold the inhaler with the mouthpiece down.</li> <li>4. Breathe out through your mouth, and push as much air from your lungs as you can.</li> <li>5. Put the mouthpiece in your mouth and close your lips around it OR keep mouthpiece 2–4 cm away from your mouth.</li> <li>6. Push the top of the canister all the way down while you breathe in deeply and slowly through your mouth. Right after the spray comes out, take your finger off the canister. After you have breathed in all the way, take the inhaler out of your mouth and close your mouth.</li> <li>7. Hold breath to comfort (5–10 s), and then breathe normally.</li> <li>8. Place the cap back on the mouthpiece, and make sure it snaps into place.</li> </ol>
Pulmicort Flexhaler	<ol style="list-style-type: none"> <li>1. Hold the inhaler upright (mouthpiece up).</li> <li>2. Twist the brown grip fully in one direction as far as it will go. Twist it fully back again in the other direction as far as it will go (it does not matter which way you turn it first).</li> <li>3. Turn your head away from the inhaler and breathe out. Do not shake the inhaler after loading it.</li> <li>4. Place the mouthpiece in your mouth, and close your lips around the mouthpiece.</li> <li>5. Inhale deeply and forcefully through the inhaler.</li> <li>6. Remove the inhaler from your mouth and exhale.</li> </ol>
Spiriva HandiHaler	<ol style="list-style-type: none"> <li>1. Open the dust cap of the HandiHaler by pressing the green piercing button.</li> <li>2. Pull the dust cap upward to expose the mouthpiece.</li> <li>3. Open the mouthpiece by pulling the mouthpiece ridge upward away from the base.</li> <li>4. Remove a Spiriva capsule from a blister cartridge.</li> <li>5. Insert the capsule in the center chamber of the HandiHaler device.</li> <li>6. Close the mouthpiece firmly until you hear a click, leaving the dust cap open.</li> <li>7. Hold the device with the mouthpiece upward, press the green piercing button until it is flush against the base, and release.</li> <li>8. Breathe out completely.</li> <li>9. Hold the HandiHaler device by the gray base (do not block the air intake vents).</li> <li>10. Raise the HandiHaler device to your mouth and close your lips tightly around the mouthpiece.</li> <li>11. Keep your head upright and breathe in slowly and deeply at a rate sufficient to hear or feel the Spiriva capsule vibrate.</li> <li>12. Breathe in until your lungs are full and hold breath to comfort (5–10 s) while removing the HandiHaler from your mouth, and then resume normal breathing.</li> <li>13. To make sure the whole dose was received, breathe out completely and inhale again as in steps 9–13 (do not press the green piercing button again).</li> <li>14. Open the mouthpiece, tip out the used Spiriva capsule, and discard.</li> <li>15. Close the mouthpiece and dust cap.</li> </ol>

### Data Analysis

The written questionnaire included 20 true/false questions, and the raw score of correct answers out of 20 was taken. The practicum test included 38 steps, and the raw scores of correctly completed steps were added together and divided by 38. The raw scores of the written and practicum were converted to percentage. See Tables 1 and 2.

Data were summarized using means and SD values for continuous variables. The normality of the variables was examined using the one-sample Kolmogorov-Smirnov test. We compared the written and practical scores at baseline for various professions (RTs, pharmacists, registered nurses, and physicians) using 1-way analysis of variance. The Bonferroni pairwise comparison test for multiple comparisons was used to compare mean scores between any 2

Table 2. A Sample of True and False Written Knowledge Questionnaire

Inhalers	Questions
MDI (ProAir)	<ol style="list-style-type: none"> <li>1. After removal of the dust cap, the canister should be shaken thoroughly.</li> <li>2. The canister should be held upright, and you should expire completely before actuating the canister.</li> <li>3. Prior to inspiration, the MDI mouthpiece may be positioned 2–4 cm in front of your lips.</li> <li>4. When using an MDI, the inspiration process should be fast and deep.</li> <li>5. After inhaling the contents of an MDI, breath should be held for &gt;20 s.</li> </ol>
HandiHaler (Spiriva)	<ol style="list-style-type: none"> <li>1. It is recommended to always store the capsules inside the sealed blisters.</li> <li>2. After placing the capsule inside the HandiHaler, the device should be shaken thoroughly.</li> <li>3. Prior to inspiration, the HandiHaler should be positioned horizontally with lips wrapped tightly around the mouthpiece.</li> <li>4. When using the HandiHaler, the inspiration process should be slow and deep so that you can hear or feel the capsule vibrate.</li> <li>5. After the capsule is pierced, it is recommended to take 2 inhalations from 1 capsule to receive a complete dose.</li> </ol>
Diskus (Advair)	<ol style="list-style-type: none"> <li>1. When the lever on the Diskus is pushed back, it indicates a dose is ready to be inhaled.</li> <li>2. When using the Diskus, the inspiration process should be slow and deep.</li> <li>3. It is not necessary to hold your breath after inhaling the contents of the Diskus.</li> <li>4. It is recommended to take an extra dose if you did not taste or feel the medicine after inhalation from the Diskus.</li> <li>5. It is recommended to wash the Diskus with mild soap and water at least once per week.</li> </ol>

different professions. A mixed factorial analysis of variance (2\*4) was conducted for the written and practical scores after controlling baseline written and practical scores. The level of significance was set at  $P \leq .05$ .

**Results**

The distribution of written and practical scores at baseline and postintervention was approximately normal ( $P > .05$ ). Baseline written scores ranged from 40 to 85 for RTs, 50 to 100 for pharmacists, 30 to 80 for registered nurses, and 40 to 75 for physicians. The baseline written scores were significantly different across groups ( $P = .002$ ). The mean written score of RTs was significantly higher than those of registered nurses and physicians ( $70.0 \pm 11.4$  vs  $60.5 \pm 14.0$ ,  $P = .02$ , and  $70.0 \pm 11.4$  vs  $54.2 \pm 11.1$ ,  $P = .01$ , respectively) (Table 3). Also, the mean written score of pharmacists was higher than those of registered nurses and physicians but not significantly ( $P = .15$  and  $.08$ , respectively).

The baseline practical scores ranged from 55.3 to 97.4 for RTs, 31.6 to 94.7 for pharmacists, 29.0 to 92.1 for registered nurses, and 29.0 to 86.8 for physicians. The baseline practical scores were significantly different across groups ( $P < .001$ ). The mean practical score of RTs at baseline was significantly higher compared with those of registered nurses and physicians ( $77.3 \pm 12.2$  vs  $67.4 \pm 15.8$ ,  $P = .002$ , and  $77.3 \pm 12.2$  vs  $56.1 \pm 8.6$ ,  $P < .001$ , respectively) (see Table 3). The mean practical score at baseline of pharmacists was higher than those of registered nurses and physicians but not significantly ( $P = .81$  and  $.11$ , respectively).

Results from the mixed factorial analysis of variance indicated that the practical score of various professions

Table 3. Mean ± SD Scores by Profession

	RTs (n = 20)	Pharmacists (n = 8)	RNs (n = 21)	Physicians (n = 14)
<b>Written</b>				
Before	70.0 ± 11.4*	78.3 ± 18.9	60.5 ± 14.0	54.2 ± 11.1
After	71.9 ± 7.9	81.7 ± 20.2	63.5 ± 12.7	55.8 ± 12.4
<b>Practical</b>				
Before	77.3 ± 12.2*	77.2 ± 8.0	67.4 ± 15.8	56.1 ± 8.6
After	83.6 ± 10.6†	82.5 ± 1.5	71.6 ± 12.2	64.0 ± 16.3

N = 63.

\* Significant difference from registered nurses and physicians.

† Significant difference between before and after.

RTs = respiratory therapists

RNs = registered nurses

improved after the intervention, yet this difference was not significant across groups (see Table 3 and Fig. 2). On the other hand, there were no significant differences in the written score after the intervention among professions examined.

**Discussion**

This study was performed to assess the knowledge of health-care providers about different inhaler devices. We also evaluated the ability of these health-care professionals to retain knowledge about the different techniques required to properly use different inhalers by watching videos provided by the pharmaceutical companies that made the inhalation devices.

The objective of this study emerged after observing that most patients from the clinic were not using their inhalers correctly. Yildiz<sup>22</sup> emphasized that repeated training on

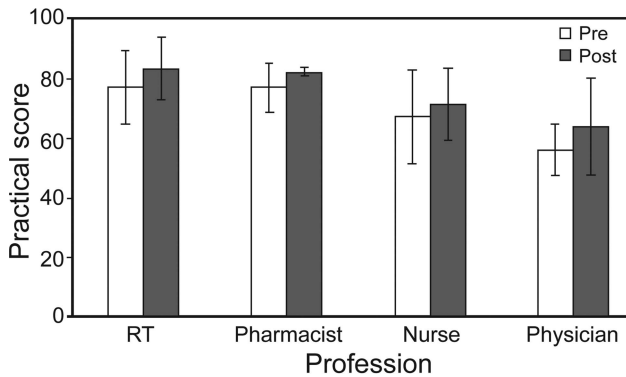


Fig. 2. Mean practical scores by profession over time. RT = respiratory therapist. Error bars denote  $\pm$  SD.

inhaler techniques will improve patient adherence to the therapy. The repetition includes frequent patient check-up/follow-up on the device technique as well as training the health-care professionals on the proper use of these devices. Thus, we decided to assess the baseline and follow-up knowledge of various health-care professionals responsible for teaching patients proper inhaler techniques.

Another concern was that with the lack of refresher courses for these different inhaler techniques, health-care professionals may forget the different details for each of the different devices. Several studies highlighted this issue in both health-care professionals and patients. Melani<sup>8</sup> concluded that changing the inhaler device would not be as effective as providing repeated health-care training for these devices. In addition, Berlinski<sup>23</sup> emphasized that providing a proper education to both health-care professionals and patients is critical to improving patient adherence.

Current inhaler devices have specific mechanisms of action for administering particle deposition. Hess<sup>24</sup> published several papers and booklets on the techniques and use of inhaler devices. In our study, we used a pressurized metered-dose inhaler, budesonide, and dry powder inhaler. The pressurized metered-dose inhaler components consist of a canister, propellant, drug formulation, metering valve, and actuator. This device has specific instructions that include priming the device before actuating. All steps were provided in our practical test that were provided for our subjects. Dry powder inhalers, on the other hand, are available in many different forms. For example, they come in a unit-dose or a multiple-dose model. We provided both types of inhalers for subjects in order to study differences in the current knowledge subjects had regarding each device. The dry powder inhaler devices require a specific amount of flow that needs to be generated by the patient for adequate delivery.<sup>24</sup>

Recently, Basheti et al<sup>25</sup> performed a 2-h face-to-face workshop to teach selected health-care practitioners how to use inhaler devices. They found that the 2-h workshop

showed a significant improvement in terms of recalling the information about each device.

In this study, we found that there is a deficiency in knowledge retention for several health-care professionals. Also, we found that the intervention of the video instrument was not effective as an education tool for health-care professionals. We thus recommend designing a strong standardized protocol to teach health-care professionals and eventually patients proper inhaler device use. We hope that the industry improves the lack of uniformity and develops a standardized method of delivery across all inhalers in order to reduce confusion about various medication delivery systems.

## Conclusions

We found that a suboptimal number of medical professionals have the proper knowledge base and the technical skill to teach inhaler technique. Therefore, we recommend further studies that develop other interventions to assess and improve learning outcomes for health-care providers, which will ultimately improve patient outcomes.

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