

# Handling of Inhaler Devices in Actual Pulmonary Practice: Metered-Dose Inhaler Versus Dry Powder Inhalers

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**BACKGROUND:** Handling of inhaler devices such as pressurized metered-dose inhalers (MDIs) and dry-powder inhalers (DPIs) in actual pulmonary practice is not well studied. **OBJECTIVE:** The aim of this study was to evaluate patients' proper handling of inhaler devices during actual pulmonary practice. **METHODS:** Prospective observational evaluations were conducted at 3 pulmonary clinics in Jordan, from February 2006 until August 2006. MDI (without spacer), Turbuhaler, Diskus, and Aerolizer devices were studied. Incorrect handling was defined as improper technique in any of the predefined essential steps. **RESULTS:** Patients ( $n = 300$ ) were recruited and 525 inhaler-device handling technique evaluations were completed. Diskus inhaler had the lowest rate of incorrect handling (7/103, 6.8%) and MDI had the highest rate of incorrect handling (144/193, 74.6%). Turbuhaler and Aerolizer were handled incorrectly by 63/146 (43.2%) and 14/83 (16.9%) patients, respectively. DPI had a lower rate of incorrect handling, when compared with the MDI ( $p < 0.001$ ). Among the DPI devices, the Diskus had the lowest rate of incorrect handling ( $p < 0.031$ ). **CONCLUSIONS:** In actual pulmonary clinical practice the majority of patients were unable to use MDI correctly, whereas correct handling of DPI devices was variable. Regular checking of inhalation technique and proper teaching by health care providers is crucial for optimum use of most inhaler devices. *Key words:* inhaler, handling, metered dose, dry powder, technique, pulmonary, actual practice. [Respir Care 2008;53(3):324–328. © 2008 Daedalus Enterprises]

## Introduction

Inhaled medications are the main therapy for bronchial asthma and chronic obstructive pulmonary disease (COPD).<sup>1,2</sup> The major advantage of inhaled therapy is that medications are delivered directly into the airways, which

produces a high local concentration with significantly less risk of systemic adverse effects. Poor handling and inhalation technique are associated with decreased medication delivery and poor disease control.<sup>3,4</sup> Different types of inhalers are available. Pressurized metered-dose inhaler (MDI) was the earliest device and is the most commonly used one. MDIs are difficult to use, have a high rate of incorrect handling (7–71%), and require patient-device coordination.<sup>3–5</sup> Dry-powder inhalers (DPIs), including Aerolizer, Diskus, Handihaler, and Turbuhaler, are flow-dependent devices and require minimal patient-device coordination.<sup>6–8</sup>

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Large systematic reviews found that MDI and DPI devices are equally effective in delivering inhaled medications.<sup>9–11</sup> However, most of those studies compared various inhaler devices in a controlled environment where

patients received structured education on proper inhalation technique. International guidelines for the management of asthma and COPD do not differentiate between various inhaler devices.<sup>1,2</sup> Device selection should be based on the availability, cost of the device, patient and physician preference, and clinical setting.<sup>9,11,12</sup>

Patients' handling of their usual inhaler devices in actual primary care or pulmonary clinical practice is not well studied.<sup>5,13</sup> A recent large observational study by Moli-mard et al<sup>5</sup> reported patients' handling of their inhaler devices in a primary care setting. The study showed that DPI devices were better handled than MDI devices, and there were differences in the handling of the various DPI devices.<sup>5</sup> These results were different from those reported in controlled trials.<sup>14,15</sup>

The present study was conducted to evaluate patients' proper handling of their usual inhaler devices (MDI, Turbuhaler, Diskus, and Aerolizer) during actual pulmonary specialty practice.

### Methods

This was a prospective cross-sectional observational study that was conducted at 3 pulmonary clinics that represent various health care sectors in Jordan: King Abdullah University Hospital, which is a major tertiary-care facility (500 beds) located in North Jordan; King Hussein Medical Center, which is a major health care facility (800 beds) located in the Jordanian capital, Amman; and Princess Basma Teaching Hospital, which is a major health care facility (200 beds) located in the city of Irbid, the second largest city in Jordan.

Data were collected in the period between February 2006 and August 2006. Patients who used inhaler devices were screened, and those who had used inhaler devices for at least 3 months were included in the study. New patients and those who had received education on inhaler use during the preceding week were excluded.

Four inhaler devices were included in the study: MDI, Diskus, Turbuhaler, and Aerolizer. Since spacer was not routinely used among our patient population and the study aim was to evaluate actual practice, the effect of adding spacer to MDI was not evaluated. Inhalers were prescribed according to the clinical indication by the treating pulmonary physician. Incorrect handling of a device was defined as improper technique resulting in incorrect performance of any of the predefined essential steps (critical error) (Table 1). These steps were derived from the medication leaflet and from previous studies.<sup>5,6,16</sup> Pharmacists who were well acquainted with the inhaler devices and their proper handling performed the evaluation procedure. They were trained by the principal investigator, at the same time, on the proper handling of each device and on how to score each step of the process. The pharmacist observed

Table 1. Frequency of Critical Errors Committed in Each Essential Step\*

Device	Essential Step	Critical Error† (n, %)
MDI (n = 193)	Remove the mouthpiece cover	6 (3.1)
	Shake the device vigorously before use	82 (42.5)
	Trigger and simultaneously breathe in	130 (67.4)
Aerolizer (n = 83)	Open the dust cap and the mouthpiece	2 (2.4)
	Insert the capsule in the well and close	5 (6)
	Push the buttons to pierce the capsule	12 (14.5)
	Breathe in rapidly and deeply	4 (4.8)
Diskus (n = 103)	Open the device	0
	Slide the lever until it clicks	7 (6.8)
	Breathe in rapidly and deeply	4 (3.9)
Turbuhaler (n = 146)	Unscrew and lift off the cover	2 (1.4)
	Hold the inhaler upright with the grip downwards	37 (25.3)
	Turn the grip until it clicks	35 (24)
	Breathe in rapidly and deeply	20 (13.7)

\*Used to evaluate the handling of each inhaler device.

†Patient made one or more errors with the device.

MDI = metered-dose inhaler

each step of the inhalation technique with a placebo device. As in previously reported similar studies,<sup>5,8</sup> incorrect handling of each essential step was subjectively reported.

An appropriate form, which included demographics and a checklist of the essential steps, was completed for each device. Potential associated factors for incorrect handling, including age, sex, primary diagnosis, and level of education of the patient, were noted.

The study was explained to the patients and an informed consent was obtained. The study was approved by the ethics committee of each participating institution.

### Statistical Analysis

Descriptive analysis was conducted on the demographics and patient characteristics. Incorrect handling among different inhaler devices was compared with Pearson's chi-square test. Factors associated with incorrect inhaler handling were analyzed with binary logistic regression analysis. A p value of < 0.05 was considered statistically significant. Analysis was performed with statistics software (SPSS version 13, SPSS, Chicago, Illinois).

Table 2. Socio-Demographic Characteristics of the Patients and Their Diagnoses

Male ( <i>n</i> , %)	140 (46.7)
Age (mean $\pm$ SD y)	48.1 $\pm$ 16.9
Age range (y)	(11–85)
Education ( <i>n</i> , %)	
No formal education	77 (25.7)
High school or higher	223 (74.3)
Diagnosis ( <i>n</i> , %)	
Bronchial asthma	219 (73)
COPD	55 (18.3)
Other diagnosis	26 (8.7)
Prior device-handling education ( <i>n</i> , %)	294 (98)

COPD = chronic obstructive pulmonary disease

## Results

A total of 300 patients (140 males and 160 females) completed the evaluation interview. The mean age was 48 years (range 11–85 y), and 42 patients (14%) were  $\geq$  70 years old. The majority (219, 73%) were suffering from bronchial asthma, and 223 patients (74.3%) had high school education or higher. Most patients (98%) reported receiving previous inhaler handling education (Table 2).

At the end of the study period, 525 inhaler-device-specific forms had been completed: 193 (36.8%) for MDI, 83 (15.8%) for Aerolizer, 103 (19.6%) for Diskus, and 146 (27.8%) for Turbuhaler. Approximately half of the patients 161 (53.7%) were simultaneously using 2 or more inhaler devices. The MDI device was incorrectly handled by 144/193 (74.6%), the Aerolizer by 14/83 (16.9%), the Diskus by 7/103 (6.8%), and the Turbuhaler by 63/146 (43.2%).

The most frequently committed critical error in handling the MDI was failure to trigger the device and simultaneously breathe in. Failure to hold the inhaler upright with the grip downwards and failure to turn the grip until it clicked were the most common critical errors in handling the Turbuhaler. In handling the Aerolizer, failure to push the buttons to pierce the capsule was the most common critical error, and with the Diskus it was failure to slide the lever until it clicked (see Table 1).

Incorrect handling was compared between the MDI and each DPI device. MDI use was associated with a higher rate of incorrect handling, when compared with Turbuhaler, Diskus, and Aerolizer devices: 74.6% versus 43.2%, 6.8%, and 16.9%, respectively ( $p < 0.001$ ). Incorrect handling was also compared between the DPI devices. The Diskus device was associated with a lower rate of incorrect handling than were the Turbuhaler or Aerolizer: 6.8% versus 43.2% ( $p < 0.001$ ) and 6.8% versus 16.9% ( $p = 0.031$ ), respectively.

Incorrect handling was compared between patients who were using one device only (74/139, 53.2%) and those who were using more than one device at the same time (120/161, 75.5%) ( $p < 0.001$ ). MDI and DPI device were used simultaneously by 132 (44%) of the patients. In that group MDI was incorrectly handled by 93 patients (70.5%) and DPI by 46 (34.8%) patients ( $p < 0.001$ ), whereas both MDI and DPI were incorrectly handled by 32 patients (24.2%).

Multivariate analysis of factors associated with incorrect handling of any of the studied inhaler devices was via binary logistic regression analysis. Multiple inhalers use and diagnosis of COPD were associated with higher odds of incorrect handling of inhalers after adjusting for age, sex, and level of education. The odds ratio for incorrect handling was 3.45 for the diagnosis of COPD (95% confidence interval 1.58–7.53) compared with bronchial asthma, and 2.92 for multiple inhaler use (95% confidence interval 1.73–4.91), compared with single inhaler use.

## Discussion

This study describes patients' handling of their inhaler devices during routine pulmonary clinical practice. Findings were in agreement with previous reports that DPI devices had significantly lower rates of incorrect handling, when compared with the MDI device. Among the DPI devices, the Diskus had the lowest rate of incorrect handling. Diagnosis of COPD and simultaneous use of more than one device were associated with higher rates of incorrect handling.

Participating clinics did not have a dedicated person to provide inhaler technique education. However, almost all patients self-reported receiving some form of education on inhaler handling technique. The currently reported high rate of incorrect handling of the MDI and Turbuhaler devices is consistent with previous results.<sup>4,5,8</sup> These high rates can be explained by the possibility that treating physicians may not spend enough time during a busy outpatient clinic to teach their patients the proper use of the inhaler device. Also, the education techniques are inadequate or done without an actual inhaler or demonstration device. Health care providers, including physicians, nurses, pharmacist, and respiratory technicians, may themselves not be acquainted with proper device handling.<sup>17–19</sup>

An MDI device is inherently more difficult to use and needs proper coordination, regardless of the quality of the inhaler technique education the patient has received.<sup>5</sup> In the current study the most frequent critical error in handling the MDI was the inability to simultaneously trigger the device and inhale slowly and deeply. Adding a spacer to the MDI helps to eliminate poor hand-lung coordination.<sup>20</sup> However the effect of a spacer was not evaluated in

this study because the spacer was not commonly used among our patients.

The most frequent critical errors in handling the Turbuhaler were failure to hold the inhaler upright with the grip downwards, and failure to turn the grip until it clicked. These handling errors can be significantly decreased with detailed and repeated education by the health care providers.

Correct handling of the studied DPI devices was variable. The Turbuhaler was the least correctly handled device, and both the Diskus and Aerolizer devices were more likely to be handled correctly. These findings are consistent with previous reports.<sup>5,7,8,21</sup> The differences in the handling of DPI devices may be related to the specific properties in the design of each device and the details (including illustrations) given in the instructions included in the package insert of each device.<sup>21,22</sup>

Structured and detailed education of patients on their inhaler device has been shown to improve patients' handling of these devices. Thus, patient education in proper handling of a prescribed inhaler device should be an essential part of the pulmonary clinic practice. This can be achieved by training an assistant to perform inhaler-handling education.<sup>23,24</sup> In addition, continuous education of health care providers, including physicians, nurses, and pharmacists, about proper inhalation technique should be implemented by hospitals and clinics.<sup>25</sup>

In controlled clinical trials, proper handling of the inhaler devices is generally required as an inclusion criteria before participating in such studies.<sup>14,15</sup> Therefore, those studies could be biased and may not reflect what actually happens in clinical practice. The difference between a controlled study environment and actual clinical practice studies in reporting proper handling of inhaler devices is important.<sup>5</sup> This study provides another important aspect of patient-device interaction. Furthermore, studies that correlate proper handling of inhalers in real practice with clinical efficacy and disease control are needed.

Patients who had COPD were less likely to handle their device correctly. This could be explained by the fact that patients with COPD are generally older and more likely to have comorbidities that may interfere with proper handling technique. Simultaneous use of various inhaler devices was also associated with a higher rate of incorrect handling. It appears that using more than one device simultaneously makes it confusing and more difficult to handle each device correctly.

Limitations of this study should be noted. Not all inhaler devices were included in this study; Handihaler and Autohaler were not included because they were not available at the study sites. The presence of more than one observer raises the possibility of inter-observer variability. Each patient in this study was observed by one pharmacist, and the inter-observer variability was not determined. This study

gave equal weight to each of the essential steps, although we realize that some steps are more critical than others.

An important step in assuring the proper use of a DPI device is the ability of the patient to generate enough flow. The finding that patients are less likely to correctly perform the step "breathe in rapidly and deeply" with the Turbuhaler (86%) than with the Diskus (96%) could be explained by the fact that Turbuhaler needs more inspiratory flow than the Diskus.<sup>26,27</sup> However, that step was assessed in a subjective way and inspiratory flow was not objectively measured. When that step was eliminated from the comparison analysis, the Diskus was still better handled than Turbuhaler, which is consistent with previous reports.<sup>5,7</sup> Other aspects of proper handling of inhaler devices were not included in this study; these include proper storage of the DPI device in order to keep it dry, and the patient's knowledge of when the device is empty.

## Conclusions

In actual pulmonary clinical practice the majority of patients were unable to use MDI correctly, whereas correct handling of DPI devices was variable. Regular checking of inhalation technique and proper teaching by health care providers is crucial for optimum use of most inhaler devices. Further and larger studies that correlate proper handling of inhalers in real practice with clinical efficacy and disease control are needed.

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