Misuse of Metered-dose Inhalers in Hospitalized Patients*

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Metered-dose inhalers (MDIs) have been associated with a high rate of misuse. Medical personnel also have a poor understanding of MDI technique. Hospitalized patients had their MDI technique observed before and after a series of inservices were provided to hospital personnel on correct MDI use. The rate of misuse did not change with 55 of 78 (76 percent) patients making errors in the first group before, and 45 of 55 (82 percent) patients making errors in the second group after staff education (p = 0.46). The average number of errors per patient was 2.39 in group 1 and 2.45 in group 2 (p = 0.93). Alternatives to deal with this high rate of MDI misuse are discussed. (Chest 1994; 105:715-17)

MDI = metered-dose inhaler

Metered-dose inhalers (MDIs) are considered a convenient, effective method for administering medication to patients with obstructive airways disease. Proper use requires proficiency in a relatively complex technique and delivers 10 to 15 percent of the actuated dose to the airways. Numerous studies in outpatient settings have documented the misuse of MDIs. Education with verbal instruction and providing a spacer device have been shown to improve MDI use.

Misuse of MDI is also prevalent among healthcare workers and may be in part responsible for MDI misuse among hospitalized patients. This misuse leads to decreased efficacy, increased side effects, and increased cost generated from unnecessary use. This study seeks to determine the incidence of misuse of MDI by patients hospitalized in a tertiary teaching facility and to determine if staff education can lead to improved patient technique.

METHODS

Adult inpatients at Madigan Army Medical Center prescribed MDIs had their technique observed over a 6-week period (August to September 1992: group 1). Medication lists on the hospital wards were reviewed to identify these patients. The observation was conducted by physicians who presented themselves as "lung doctors who checked all patients on their use of their inhaler." These physicians had no input or involvement with the patient's care while being hospitalized. Patients were asked to take two puffs of their inhaler and their technique was judged using eight steps described as the proper use of MDI. The investigator did not provide any coaching or teaching to the patient. The patients were observed a second time on the following day. All errors that persisted over the 2-day period were counted as misuse. After the assessment, the patients were asked about prior experience and education in using MDI. Their inpatient charts were also reviewed to determine their hospital admission diagnosis.

The eight steps are based on the recommendations of the National Institutes of Health (NIH) review committee for the treatment of asthma (Table 1). The patient must shake the canister before each actuation. The patient then places the canister in an upright position at the opening of the mouth. Correct positioning is allowed when the MDI was in contact with the mouth or up to 4 cm away. The patient must begin a slow breath just prior to actuation of the MDI unless using a spacer device. The patient then actuates the MDI once and continues a slow breath to total lung capacity. The timing of the actuation was correct if it occurred anywhere during the first third of the inhalation, including simultaneous to the start of inhalation. In patients using a spacer, the slow breath to total lung capacity is initiated after actuation. The patient then holds his/her breath for at least 4 s. Although a 10-s breath hold has been recommended, some patients cannot achieve this and therefore the more liberal requirement of 4 s was used. Finally, the patient waits at least 30 s before the next actuation.

After this initial 6-week evaluation, an education program was carried out by a pharmaceutical representative who had extensive training in the use of the MDI and methods of teaching patients in their proper use. The education was directed at the internal medicine house staff, nursing personnel, and respiratory therapists. Two identical 1-h presentations were provided to each shift on each nursing ward and to the respiratory therapy staff. The house staff were taught during a 1-h session. The presentations stressed the importance of proper use, the method for proper use, the high rate of misuse among patients, and the need for frequent teaching and reteaching proper technique to patients. The sessions included practice by the healthcare professionals using placebo MDIs and an aerosol inhalation monitor that gave feedback on their technique. These inservices were completed over a 2-month period (September to October 1992).

Table 1—Steps Required for Proper MDI Use*

<table>
<thead>
<tr>
<th>MDI Alone</th>
<th>MDI With Spacer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Shake canister</td>
<td>1—Shake canister</td>
</tr>
<tr>
<td>2—Hold canister upright at opening of mouth</td>
<td>2—Hold canister upright with spacer in mouth</td>
</tr>
<tr>
<td>3—Begin a slow breath</td>
<td>3—NA</td>
</tr>
<tr>
<td>4—Actuate the MDI once</td>
<td>4—Actuate the MDI once</td>
</tr>
<tr>
<td>5—Continue slow breath</td>
<td>5—Take slow breath</td>
</tr>
<tr>
<td>6—Breathe in to total lung capacity</td>
<td>6—Breathe in to total lung capacity</td>
</tr>
<tr>
<td>7—Hold breath for at least 4 s</td>
<td>7—Hold breath for at least 4 s</td>
</tr>
<tr>
<td>8—Wait at least 30 s before next actuation</td>
<td>8—Wait at least 30 s before next actuation</td>
</tr>
</tbody>
</table>

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CHEST / 105 / 3 / MARCH, 1994 715

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After this period of education, a second group of inpatients was observed using the MDI in the same fashion as the first group over a 6-week period (November to December 1992: group 2). The hospital personnel were unaware that this posteducation evaluation was being carried out. The rate of misuse before and after the education were compared using the two-sample test for binomial proportions. The number of errors per patient before and after education was compared using the Mann-Whitney U test.

**Results**

There were 72 patients (42 men, 30 women) in group 1 with a mean age of 60 years (range, 19 to 86 years) and 55 patients in group 2 (36 men, 19 women) with a mean age of 63 years (range, 32 to 85 years). Spacer devices were used by 31 patients (43 percent) in group 1 and 18 patients (32 percent) in group 2. Misuse of the MDI occurred in 55 patients (76 percent) in group 1 and 45 patients (82 percent) in group 2 (p = 0.46). The average number of errors per patient was 2.39 in group 1 and 2.45 in group 2 (p = 0.93). The most frequent errors were failure to initiate a slow breath prior to actuation, failure to breath hold, failure to inhale to total lung capacity, and failure to wait at least 30 s between inhalations (Fig 1). The rate of misuse was high even in the patients who were admitted to the hospital for an acute pulmonary process, with 40 of 63 patients (63 percent) in group 1 making errors and 21 of 25 patients (84 percent) in group 2 (p = 0.06).

Patient experience using the MDI (continuous use for greater than 6 months prior to hospital admission) did not change the rate of misuse (group 1: 37 of 51 patients [73 percent]; group 2: 33 of 39 patients [85 percent]). The use of a spacer device eliminated the most common error (failure to initiate slow breath prior to actuation) and when the two groups were combined it significantly decreased the number of errors per patient (2.74 without spacer, 1.90 with spacer; p = 0.027) as well as the number of patients making errors (66 of 78 [85 percent] without spacer, and 34 of 49 [69 percent] with spacer; p = 0.04). Since more patients in group 1 used spacer devices, the patients who did not use a spacer in each group were compared. The number of patients making errors without spacers in group 1 was 34 of 41 (82 percent) and the number in group 2 was 32 of 37 (86 percent) (p = 0.66). The number of errors per patient not using a spacer in group 1 was 2.61 and was 2.89 in group 2 (p = 0.64).

Disappointingly, only 15 of the 55 patients in group 2 stated that they had received instruction in the use of the MDI during their hospitalization and only 1 of these patients used his MDI correctly.

**Discussion**

This study confirms a high rate of MDI misuse among hospitalized patients. Only 27 of the total 127 patients observed used their inhaler correctly. Although spacer devices decreased the average number of errors per patient as well as the total number of patients making errors, more than two thirds of the patients using a spacer used them incorrectly. Numerous other reports also show a high rate of misuse among outpatients, but only three studies reported misuse among inpatients. Roberts et al observed 42 male patients prescribed MDI at a VA hospital and found an initial 55 percent rate of misuse that improved with personal education from a pharmacist. Shim and Williams studied 30 hospitalized patients and found a 47 percent rate of misuse of MDIs. The patients with poor technique were instructed in the proper use of MDI until they demonstrated good technique, but only 50 percent used the MDIs correctly on follow-up observation 1 to 30 days later. King et al reported that 39 of 57 patients (68 percent) in a British general hospital misused their MDI and stressed the high cost of MDI misuse.

A recent study of medical personnel revealed a high rate of misuse among physicians, nurses, and respiratory therapists. We believed it was important to educate all hospital personnel involved in care of patients using MDIs in order to improve patient technique as suggested recently by Interiano and Guntupalli. Unfortunately, the education we provided in the form of inservices did not improve the rate of MDI misuse among patients hospitalized in a tertiary care teaching facility. Of concern is that only 27 percent of the patients received instruction despite the inservices stressing the need for patient education. Although they reported receiving instruction, 14 of these 15 patients used the MDI incorrectly. This could be due to failure of the instructor or failure of the instructor to know proper technique.

There are several potential biases inherent in this study. The observers were unblinded and the results are dependent on their personal interpretation of correct technique. We tried to eliminate this bias as much as possible by designating eight predetermined steps to document correct technique, and the same
three investigators (K. G., T. I., and J. T.) observed the patients before and after the staff education. Since the ideal lung volume prior to inhalation is controversial,1 the degree of exhalation prior to inhalation was not assessed. A slow exhalation prior to inhalation and actuation can improve patient technique.24 Another possible bias is that the inservice was provided to internal medicine house staff only, and some rotating house staff who did not receive the MDI education could have been caring for patients in group 2. However, the teams would have included a supervising resident who did attend the inservice. Also, there may have been some turnover among the nursing staff, but this is estimated to be less than 5 percent. There was no turnover among respiratory therapists during the study period. One might also argue that since more patients used spacer devices in group 1 than in group 2, the study was biased against an effect of staff education. However, comparison of patients not using a spacer also showed no benefit of staff education.

The task of teaching MDI technique to patients was not assigned to any one of the professional groups involved, which may have led to the assumption that someone else would do the teaching. These groups are typically overworked and a repetitive task such as MDI education may be overlooked. Our hospital does not have the manpower to dedicate a team to the task of educating every patient prescribed an MDI. However, the obvious cost of this degree of misuse must be addressed. Some studies suggest that alternative inhalers, such as spinhalers, diskhalers, rotahalers, or autohalers may be associated with less misuse.20, 21 Many studies have documented the efficacy of patient education, yet the effect erodes with time.2 Even with excellent education, 15 percent of patients attending an asthma clinic had poor technique.25 It is suggested that patients who demonstrate persistently poor technique should be treated with home nebulizers.23 This is the usual approach to inpatients who fail to clear their bronchospasm with the MDI, that is, order nebulized bronchodilators. Our study would suggest that the conditions of these patients might improve if they had better technique with their MDI.

Our hospital plans to adopt a video MDI teaching program that will be mandatory for any inpatient prescribed MDI. Videotape teaching programs have been shown to be as effective as personal teaching.23 The video will also include advice to the patients to demonstrate their technique to their physician so that efficacy of the education can be observed. Spacer devices are made available to any inpatient for whom the physician orders them and are demonstrated personally by a respiratory therapist. Spacer devices are prescribed routinely for patients inhaling corticosteroids to decrease oral deposition. Clinical pharmacists will be involved in checking that the patients receive proper education. Finally, as part of total quality management, the efficacy of these interventions will be studied at a later date.

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References

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