

# Dose counting and the use of pressurized metered-dose inhalers: running on empty

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**Background:** Pressurized metered-dose inhalers (pMDIs) are the cornerstone of asthma treatment. The pMDI is an economic and portable medication delivery system, but the device does not indicate how much medicine remains in the canister once a patient starts using it.

**Objective:** To determine how patients evaluate the contents of their pMDI and whether they are either discarding inhalers when medication remains or using inhalers beyond the indicated number of doses.

**Methods:** This study was conducted in April 2003 via a 6.5-minute telephone interview with a random sample of 500 families with asthma from across the United States.

**Results:** Of the 500 respondents participating in the telephone interview, nearly one third (31.6%) named an inhaled corticosteroid or bronchodilator and inhaled corticosteroid combination as the inhaler used when wheezing, coughing, or short of breath. Respondents using a bronchodilator (n = 342) varied in the frequency with which they use their pMDIs: 31.9% daily, 18.7% weekly, 23.4% monthly, and 23.1% less than once per month. More than half (53.8%) of bronchodilator users refill their prescriptions more frequently than recommended by national guidelines. Only 36% of bronchodilator users reported ever having been told to keep track of pMDI doses used. Of those, 79% had been advised to do so by a physician, 6% by a pharmacist, and 3% by a nurse. Eighty-seven (25%) of the 342 respondents who named a bronchodilator reported having found their pMDI empty during an asthma exacerbation. Seven of those patients had to call 911. Of these 87 patients, 71 (82%) considered their pMDI empty when absolutely nothing came out.

**Conclusions:** Patients do not have a reliable means of monitoring the contents of their metered-dose inhalers, which is causing serious problems that need to be addressed. Given the necessity of a reliable dose counting method, it is clear that manufacturers should include dose counters as a standard feature of every metered-dose inhaler.

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## INTRODUCTION

As the mortality rate of asthma increases, it becomes increasingly important to examine the efficacy of asthma treatment and medication delivery systems. Pressurized metered-dose inhalers (pMDIs) are the cornerstone of this treatment, involved in the delivery of maintenance medication such as inhaled corticosteroids (ICSs) and short-acting bronchodilators for acute asthma episodes and the prevention of exercise-induced symptoms.

Although the pMDI is economic and portable, the device does not indicate how much medicine remains inside the canister once a patient starts using it. Lacking this information, patients may either discard the inhaler before it has been fully used or continue to use the inhaler beyond its labeled number of doses, at which point the quality of each puff is no longer guaranteed by the manufacturer. Because it is so critical that patients use their inhaler properly to optimize treatment, the aim of this study was to determine how patients evaluate the contents of their pMDI and whether they are

either discarding inhalers when medication remains or using inhalers beyond the indicated number of doses.

## METHODS

This study was conducted in April 2003 via a 6.5-minute telephone interview, in which respondents were asked several questions regarding their asthma and inhaler use. A random sample of 500 families was chosen from a list provided by the Allergy & Asthma Network Mothers of Asthmatics (AANMA), which included the names of 3,700 non-AANMA member families who had at some point contacted AANMA with asthma-related inquiries. The following questions were asked:

1. What is the name of the inhaler you use to treat coughing, wheezing, or shortness of breath? (Only respondents naming a bronchodilator proceeded beyond this question.)
2. How often is the inhaler typically used?
3. How often do you typically get the inhaler prescription refilled?
4. Have you ever been advised to keep track of the number of doses used?
5. (If yes to question 4) Who gave you this advice?
6. Have you ever been told or shown how to find the number of doses contained in a newly purchased inhaler?
7. Do you know where to find this information?

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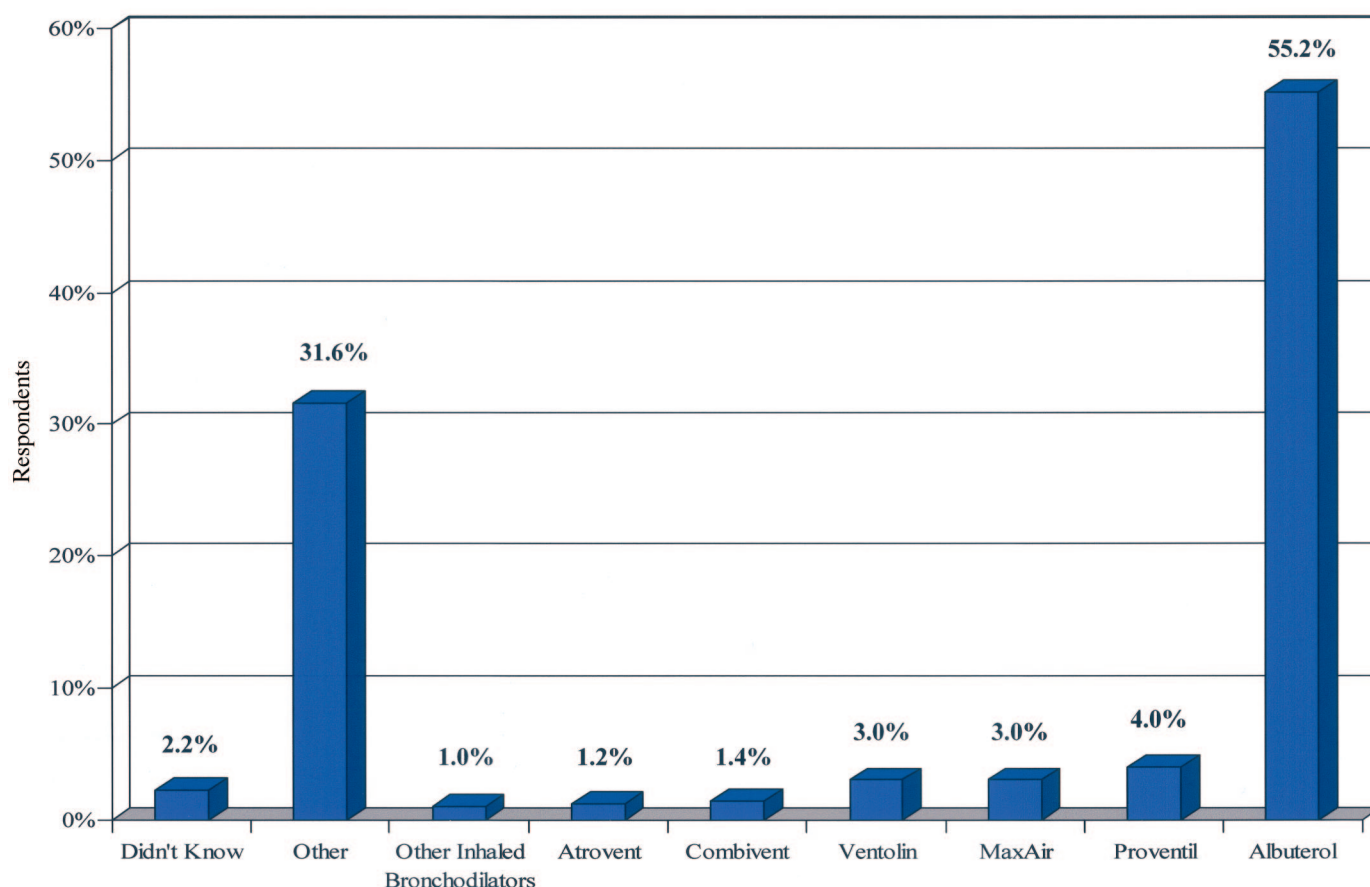


Figure 1. Types of inhalers used. Other indicates inhaled corticosteroid or inhaled corticosteroid and bronchodilator combination.

8. Can you tell me how many doses remain in the inhaler right now?

9. How many doses remain?

10. How did you arrive at this number?

11. Have you ever needed the inhaler and found it was empty?

12. How did you know the inhaler was empty?

13. What did you do when you discovered the inhaler was empty?

14. Do you live in a city, suburb, small town, or the country?

15. Would you mind telling me the highest level of education you've completed?

Of the 500 respondents, 5 children (younger than 18 years) responded for themselves; the rest were adults answering for themselves and/or any family members with asthma. Interviews were conducted by Specifics Incorporated, Atlanta, GA, between April 16 and 24, 2003, with funding provided by Sepracor, New Marlborough, MA.

## RESULTS

Of the 500 respondents participating in the telephone interview, nearly one third (31.6%) named an ICS or bronchodi-

lator-ICS combination as the inhaler used when wheezing, coughing, or short of breath (Fig 1). Roughly two thirds (342) of the 500 respondents named a bronchodilator.

Of the 342 households using a bronchodilator, 34.8% contained an adult with asthma (84% female; average age, 46 years), and 78% contained at least one child with asthma (59% male; average age, 9 years). (The higher than average percentage of female respondents in this study was a result of the fact that interviewees were selected from AANMA's patient list, which is largely composed of female patients and mothers of asthmatic children.) Education levels among adult respondents were as follows: 15.8% had a high school diploma or less, 31.9% had less than 4 years of college, 33.6% had earned a 4-year college degree, and 16.4% had an advanced or graduate degree.

Respondents using a bronchodilator ( $n = 342$ ) varied in the frequency with which they use their pMDIs: 31.9% daily, 18.7% weekly, 23.4% monthly, and 23.1% less than once per month (Fig 2). More than half (53.8%) of bronchodilator users refill their prescriptions more frequently than recommended by national guidelines (Fig 3).

Only 36% of bronchodilator users reported ever having been told to keep track of pMDI doses used. Of those, 79%

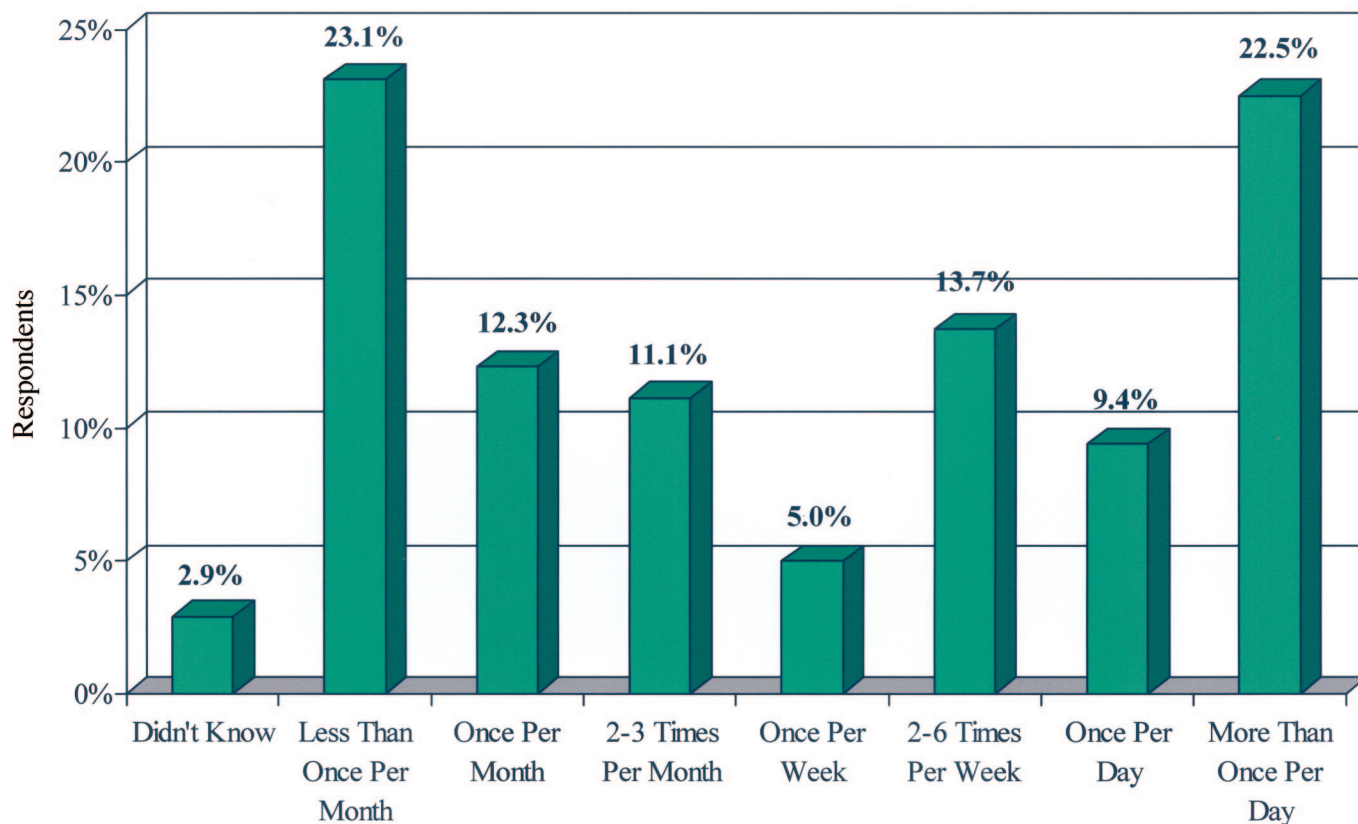


Figure 2. Frequency of bronchodilator pressurized metered-dose inhaler use.

had been advised to do so by a physician, 6% by a pharmacist, and 3% by a nurse.

Eighty-seven (25%) of the 342 respondents who named a bronchodilator reported having found their pMDI empty during an asthma exacerbation. Seven of those patients had to call 911. Of these 87 patients, 71 (82%) considered their pMDI empty when absolutely nothing came out.

## DISCUSSION

This study produced a number of alarming statistics. First, when asked the name of the inhaler used when wheezing, coughing, or short of breath, 31.6% of respondents named something other than a bronchodilator. We must approach this result with caution, because it potentially overestimates the percentage of patients who actually use the wrong inhaler during an attack. It is possible, for instance, that patients differentiate between their inhalers by appearance and not by name and so mistakenly named the wrong inhaler when in fact they are using the correct one or perhaps parents responding for their children gave an incorrect response when their children in fact know which inhaler to use. Yet if these errors potentially overestimate, it is just as possible that they *underestimate* and that even more than one third of patients are using their inhalers incorrectly. Clearly, further research is

needed to better understand this statistic and to evaluate the lack of education that may be leading to inhaler misuse.

Second, more than half of bronchodilator users refill their prescription more frequently than they should. According to national guidelines, daily use of a bronchodilator is not recommended and reflects poor asthma management. Given that a bronchodilator pMDI contains either 200 actuations (albuterol) or 400 actuations (pirbuterol), patients should only need to refill their inhaler once or twice per year. Yet almost 20% of respondents reported refilling their inhaler at least once per month. These data may reflect a number of possibilities: patients' asthma is poorly managed, patients do not know that bronchodilators should not be used daily, or patients are throwing away partially used inhalers, perhaps to prevent finding their inhaler empty during an attack. Any one of these explanations is problematic. Also, because this study did not produce data on the effect of exercise-induced asthma on bronchodilator use and refill rates, further research is needed in this regard.

Third, respondents clearly demonstrated that they have no reliable means of knowing how many doses are left in their inhalers. The pMDI is unique for this reason: it is the only medication delivery system approved by the Food and Drug Administration (FDA) that does not allow patients to re-

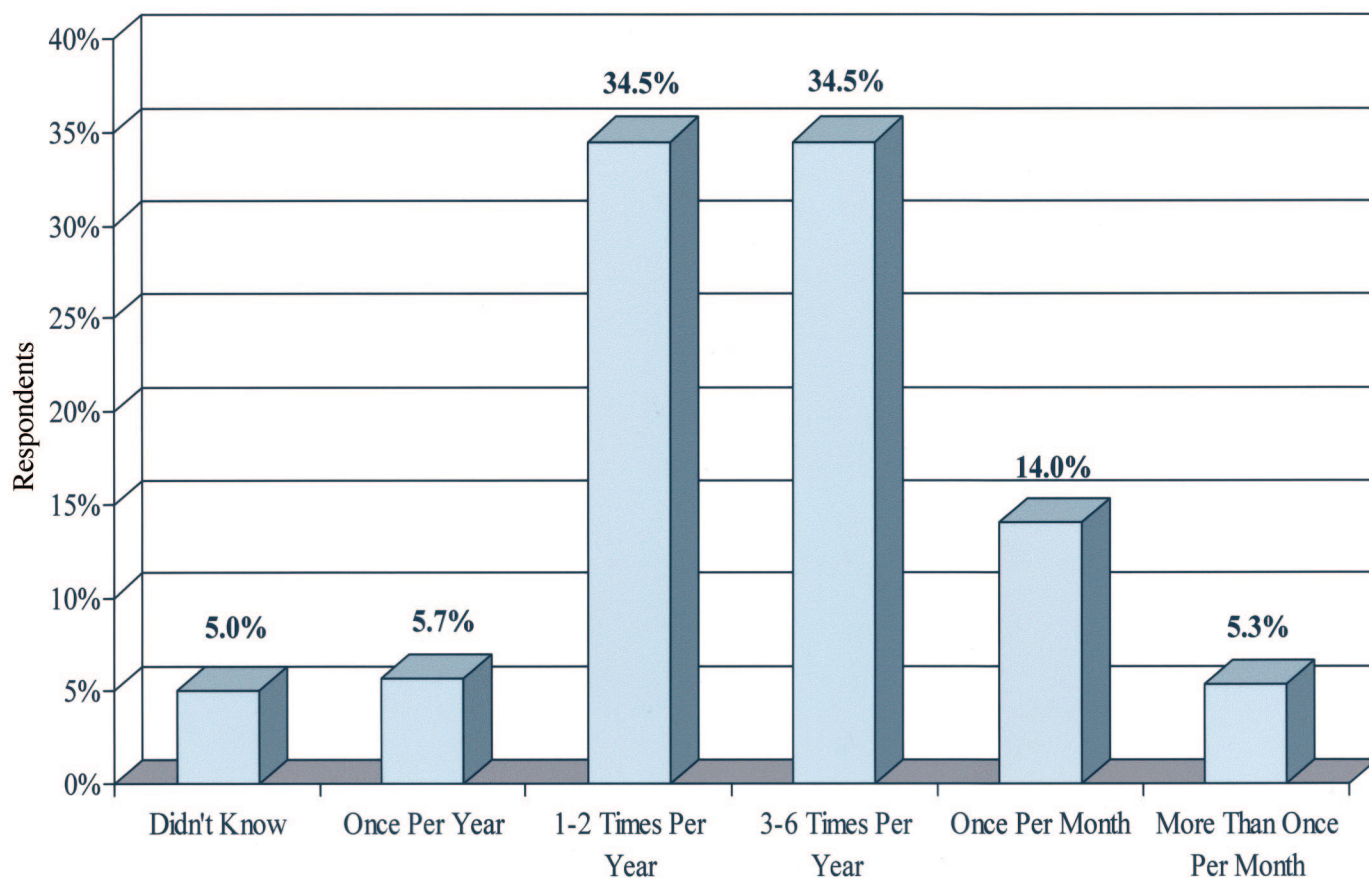


Figure 3. Frequency of bronchodilator pressurized metered-dose inhaler prescription refill.

liably tell if they have medication left as they continue to use it.

Patients have a number of options to determine whether medication remains in the pMDI, all of which are faulty. The FDA recommends that patients keep a diary of inhaler use and discard the inhaler on reaching the labeled number of doses, even though the inhaler may appear to continue delivering medication. This method, however, is cumbersome and issues of compliance render it wholly impractical, especially for patients using their pMDI on an irregular basis, as with bronchodilators. In one survey, only 8% of respondents determined when to replace their pMDI by counting the number of actuations used.<sup>1</sup>

The method of assessing inhaler contents most commonly used by patients in this study was spray testing. Nearly 82% of respondents who had found their inhaler empty when needed decided it was empty when absolutely nothing came out; an additional 3.4% decided based on the strength of the puff. Inhalers on the market today contain propellant in addition to medication and are made to actuate many more times than stated on the label. However, as package inserts caution, the quality of each puff cannot be assured after the labeled number of doses has been reached. The spray test

may therefore lead patients to believe that medication remains in the canister when the accuracy of each dose is in fact degrading.<sup>2</sup> Testing the inhaler by shaking it, a method used by 83% of patients in one survey,<sup>3</sup> is similarly misleading, because propellant or other inert contents may remain in the canister even after all medication has been consumed. Studies have shown that the percentage of additional actuations contained in pMDIs ranges from 20% to 80% of the labeled dosage.<sup>4,5</sup>

Finally, patients may test the inhaler by floating its canister in water and noting its position. Numerous studies have been performed to determine whether the flotation method is a reliable way of assessing pMDI contents.<sup>4-8</sup> In one study, Wolf and Cochran<sup>7</sup> concluded that each product has a unique yet reproducible flotation pattern that, if such information were included in package inserts, could help patients determine with accuracy whether medication remains. However, to date no study has been able to determine a general float test that can be used to evaluate the fullness of any given pMDI canister. In fact, many package inserts warn patients against immersing or floating the canister in water, because doing so may threaten product integrity. Supporting this claim is a study conducted by Rubin and colleagues, which found



that canister flotation caused valve obstruction 27% of the time.<sup>4</sup>

## CONCLUSION

Two facts emerge from this study and those cited herein. First, patients do not have a reliable means of monitoring the contents of their metered-dose inhalers. It is well known and uncontested that shake testing and spray testing are misleading, and the flotation method has been repeatedly shown to be both inaccurate and potentially damaging to the product. The only FDA-approved approach is for patients to keep track of doses as they use them, but demanding a practice as cumbersome as this is impractical.

Second, not having a reliable means of assessing pMDI contents is causing serious problems that need to be addressed. As the results of this study show, refill rates are much higher than they should be. Although the causes of this problem are, of course, a matter of speculation, it seems reasonable to conclude that the lack of a reliable dose counting method is contributing to the unnecessary frequency with which patients feel that their inhaler needs to be replaced.

Even more troubling than the 54% of patients who refill their prescription too often are the patients who are apparently not replacing their inhaler often enough: 25% reported having found their inhaler empty during an attack. It is wholly unacceptable that so many patients, believing they are equipped with the means to manage their asthma and life-threatening episodes, are actually using an empty inhaler and putting their lives at risk simply because they do not know whether their inhaler contains medication and have no way of making that determination.

For these reasons, we highly recommend that all pMDIs be equipped with integrated dose counters or indicators. This would eliminate the uncertainty that patients currently face in assessing inhaler contents. Dose counters may help to improve the cost-effectiveness of asthma management by regulating refill rates and reducing hospital visits. More importantly, dose counters would ensure patients have medication on hand when they need it, thereby granting them the security inherent in reliable disease management. Williams and colleagues join us in expressly recommending the use of dose counters, concluding that "aerosol metered dose inhalers give insufficient information about the drug remaining in the inhaler and are therefore unsafe" and "a counter mechanism would rectify the problem."<sup>9</sup>

Since the development of the Diskus inhaler, which was the first inhaler to come equipped with a dose counter, numerous studies have shown the extent to which patients appreciate the value of the dose counter. When patients are asked to rate the importance of inhaler features, dose counters consistently rank in the top 5.<sup>10–13</sup> Also, in studies asking patients to choose between the Diskus inhaler and another inhaler that does not have a dose counter, most patients prefer the Diskus and tend to cite the presence of the dose counter

as the main reason for their preference.<sup>10,12–15</sup> Given the necessity of a reliable dose counting method and the fact that most patients find dose counters desirable, it is clear that manufacturers should include dose counters as a standard feature of every pMDI.

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