

Original Article

Inhaler Use in Hospitalized Patients with Chronic Obstructive Pulmonary Disease or Asthma: Assessment of Wasted Doses

Sami Sakaan, PharmD, BCPS^{*}; Dagny Ulrich, PhD[†]; Jenny Luo, PharmD[‡];
Christopher K. Finch, PharmD, BCPS^{§,§}; and Timothy H. Self, PharmD^{¶,**}

ABSTRACT

Background: Hospitalized patients with chronic obstructive pulmonary disease (COPD) or asthma routinely have inhaled medications ordered for acute and maintenance therapy. Treatment may be administered via metered-dose inhaler (MDI) or dry-powder inhaler (DPI). These products must be appropriately labeled to be released home with the patient or discarded before discharge.

Objective: To assess the amount and estimated cost of wasted doses of medications via MDI or DPI for hospitalized patients with COPD/asthma.

Methods: A retrospective study was conducted at a university-affiliated hospital. Patients admitted between January 2011 and June 2012 with a primary diagnosis of COPD or COPD with asthma and who were ≥ 40 years of age were included. Information collected included use of albuterol, ipratropium, inhaled corticosteroids, long-acting beta agonist, or tiotropium and whether treatments were given by nebulizer, MDI, MDI plus valved holding chamber (VHC), or DPI. The number of doses dispensed, as well as doses not used, via MDI, MDI + VHC, or DPI were collected from electronic medical records. Costs associated with wasted medications were evaluated.

Results: Of 555 patient admissions screened, 478 (mean age, 66 years; 58% women; 74% African American) met study criteria. Of the total MDI or DPI doses dispensed, 87% were wasted, and associated hospital cost was approximately \$86,973.

Conclusions: Substantial waste of inhaled medications was found in our study. Practical strategies are needed to reduce wasted inhalers. Further assessment of this problem is needed in other US hospitals.

Key Words—hospitalized COPD patients, inhalers, waste

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Chronic obstructive pulmonary disease (COPD) is the third leading cause of death in the United States and causes roughly 800,000 hospitalizations annually.^{1,2} Asthma affects 24 million Americans and results in close to 500,000 hospitalizations each year.^{1,3} Treatment algorithms for acute exacerbations of both asthma and COPD are similar and

well established.^{3,4} Inhaled therapies for hospitalized patients with COPD routinely include albuterol and ipratropium.⁴ Hospitalized patients with asthma routinely receive inhaled albuterol and frequently also receive ipratropium, even though the evidence for use beyond the emergency department is lacking.³ In addition, many patients are either continued on maintenance

*Clinical Pharmacist, Methodist University Hospital, Memphis, Tennessee; [†]University of Tennessee Health Science Center, Memphis; [‡]Assistant Director, Clinical Pharmacy Services, Methodist University Hospital, Memphis, Tennessee; [§]Associate Professor of Clinical Pharmacy, University of Tennessee Health Science Center, Memphis; [¶]Professor of Clinical Pharmacy, University of Tennessee Health Science Center, Memphis; ^{**}Program Director, PGY2 Internal Medicine Pharmacy Residency, Methodist University Hospital, Memphis, Tennessee. Corresponding author: Dr. Timothy H. Self, University of Tennessee Health Science Center, Department of Clinical Pharmacy, 881 Madison Avenue, Room 235, Memphis, TN 38163; e-mail: tself@uthsc.edu

inhaled medications from home or have new inhaled therapies initiated during the hospital stay.^{3,4}

Inhaled medications, such as albuterol, are most frequently administered via nebulization. Nebulizers are used in part due to a longstanding tradition and because acutely ill patients may not have the mental or physical ability to use an MDI or MDI plus valved holding chamber (VHC) or “spacer.” However, for over 20 years, several double-blind studies have clearly demonstrated that, correctly used, MDI + VHC has an equivalent efficacy to nebulizers.⁵⁻¹³ Despite this evidence, some institutions have met resistance to changing from nebulizers to MDI or MDI + VHC.^{14,15} Nevertheless, many hospitalized patients with COPD/asthma will have albuterol or albuterol-ipratropium MDI ordered. Furthermore, long-term maintenance drug therapy, including inhaled corticosteroids (ICS), ICS plus long-acting inhaled beta₂ agonists, and inhaled tiotropium are frequently ordered for hospitalized patients. These drugs may be administered via MDI or dry-powder inhaler (DPI). A major economic and practical concern with using MDI or DPI in hospitalized patients is that inhalers (or any other prescription medication) must be labeled per state boards of pharmacy regulations for home use (after hospital discharge) by the pharmacy department. Consequently, strict adherence to these regulations dictates that inhalers should be discarded and not given to patients to take home (unless they have proper prescription labeling). Unfortunately, many hospital pharmacies do not have adequate staff or time to provide such labeling at the time of discharge. To our knowledge, there are no peer-reviewed publications evaluating the specific number of doses of inhaled medications dispensed versus doses administered. To reduce inhaler waste among inpatients, some institutions have reported using a common MDI canister protocol with positive results.¹⁶⁻²² However, this approach does not address the waste of inhalers at the time of discharge. Many patients cannot afford these expensive drugs, which increases their risk of suffering.

The purpose of this study is to assess the amount of wasted doses of medications ordered via MDI or DPI for hospitalized patients with COPD/asthma. In addition, our goal was to assess the costs associated with wasted doses (inhalers discarded at the time of patient discharge from the hospital).

METHODS

Patients admitted to Methodist University Hospital (MUH; Memphis, Tennessee) between January

2011 and June 2012 with a primary diagnosis of COPD or COPD with asthma exacerbation per ICD-9 codes (*International Classification of Diseases*, 9th revision) and who were 40 years old and older were included in this study. Patients with asthma without a diagnosis of concomitant COPD were excluded.

This single-center, retrospective study was conducted at a 690-bed, university-affiliated teaching hospital following approval by the institutional review board. The study complied with the Declaration of Helsinki. Patients were identified through a database query generated by health information management. Baseline characteristics were recorded including date of admission, age, race, gender, smoking history, past medical history, and outpatient medication regimen. Information collected pertaining to inpatient inhaled treatment regimens included the use of albuterol, ipratropium, long-acting inhaled beta₂ agonists, inhaled corticosteroids, or tiotropium and whether treatments were given by nebulizer, MDI, MDI + VHC, or DPI. The number of doses of inhaled medications via MDI, MDI + VHC, or DPI was collected according to documentation in the electronic medical record (EMR). For MDI, MDI + VHC, or DPI, the number of doses dispensed and the doses not used (wasted) were recorded. For example, if a 200-puff albuterol MDI was dispensed and 2 puffs every 4 hours were charted for 2 days, then 24 puffs were administered and 176 puffs were wasted (MDI was thrown away at time of patient discharge per current regulations). Costs associated with wasted medications were evaluated.

MUH utilizes one EMR in which respiratory therapists document medications administered, as nurses do for other medications. The respiratory therapy department does not procure any medications outside of the pharmacy department.

Data obtained from the medical record were recorded on a standard data collection form and entered into an Access database. Descriptive statistics were used for this study population.

RESULTS

During the 18-month study period, there were 555 admissions for COPD or COPD/asthma as the primary diagnosis. Among these admissions, 478 patients (mean age, 66 years; 58% women; 74% African American) met study criteria. Of the patients included in the study, 63 were admitted more than once. Table 1 outlines the characteristics of the patients in the study. The majority of patients were receiving a short-acting beta₂ agonist inhaler,

a long-acting beta₂ agonist inhaler, and an ICS prior to admission. Also, 60% of patients were receiving a long-acting anticholinergic inhaler at home prior to hospitalization. One third of patients were reported as current smokers. The mean length of hospital stay was 5 days.

Per our hospital formulary, inhalers are dispensed as multidose MDI/DPI as follows: albuterol = 60 inhalations; ipratropium = 120 inhalations; tiotropium = 5 inhalation capsules; formoterol = 12 inhalation capsules; fluticasone = 120 inhalations; budesonide/formoterol = 60 inhalations; fluticasone/salmeterol = 14 inhalations.

Table 1. Baseline characteristics of study patients (*N* = 478 admissions)

Characteristics	<i>n</i> (%) or mean ± <i>SD</i>
Age, years	66 ± 11
Weight, kg	76 ± 17
Length of hospital stay, days	5 ± 3
Female sex	278 (58%)
Race	
African American	354 (74%)
Caucasian	119 (25%)
Hispanic/Other	5 (1%)
Home COPD medications	
Short-acting beta agonist inhaler	408 (85%)
Long-acting beta agonist inhaler	352 (74%)
Inhaled corticosteroids	363 (76%)
Short-acting anticholinergic inhaler	185 (39%)
Long-acting anticholinergic inhaler	285 (60%)
Leukotriene modifier	42 (9%)
Theophylline	39 (8%)
Past medical history	
Diabetes	171 (36%)
Congestive heart failure	155 (32%)
Peptic ulcer disease	26 (5%)
GERD	107 (22%)
Hypertension	377 (79%)
Coronary artery disease	136 (28%)
Cigarette smoking history	
Current smoker	159 (33%)

Note: COPD = chronic obstructive pulmonary disease; GERD = gastroesophageal reflux disease.

The majority of patients (97%) included in the study received nebulized albuterol (total doses = 8,081) ± ipratropium (total doses = 6,755).

Our results show that the percentage of wasted doses was remarkable. Of the total MDI or DPI doses dispensed, 87% were wasted, at an estimated hospital cost of \$86,973. For example, 93% of budesonide/formoterol doses were wasted, resulting in an estimated hospital cost of \$41,021. Also, 98% of the dispensed doses of MDI albuterol and fluticasone were wasted. Results including MDI/DPI doses dispensed, inhaled, and wasted as well as the estimated hospital cost associated with the wasted doses of each inhaler are summarized in Table 2.

DISCUSSION

Among roughly 1.3 million hospital admissions for COPD and asthma each year in the United States, the economic waste associated with unused doses of medications via MDI and DPI is high. There is also a considerable toll in human suffering for patients who cannot afford to buy the medication at discharge. These patients are more likely to decompensate at home and have a greater risk of readmission to the hospital. Our study found that 87% of dispensed MDI/DPI doses were wasted, and the estimated hospital cost associated with the waste was \$86,973. At MUH, there is no reimbursement for medications. MUH is reimbursed by diagnosis-related group (DRG). Because MUH dispenses inhalers with multiple daily doses, patients are charged for the entire device. MUH charges for medications on dispensing rather than administration. For a very crude estimate of economic waste based on results from our study, the average hospital cost of wasted inhaler doses alone per patient was \$182; if similar waste occurs in other hospitals, the waste per patient multiplied by ~1.3 million admissions for COPD/asthma annually would yield an estimated hospital waste in the United States of more than \$236 million. The cost of the waste is remarkable, but the human suffering is even greater, especially since many of these patients are indigent. Dispensing partially used multidose inhalers for discharge ensures that patients have a continued initial supply and allows more time for patients to fill prescriptions after discharge.

To our knowledge, this is the first study to assess wasted doses of MDI and DPI in hospitalized patients in the peer-reviewed literature. Conzelmann and colleagues²³ acknowledged this problem and proposed a practice of labeling MDI/DPI appropriately before patients discharge from the hospital. In this health

Table 2. Metered-dose inhaler (MDI)/dry-powder inhaler (DPI) doses dispensed versus wasted and the estimated hospital cost of wasted doses (*N* = 478 admissions)

Variable	Doses dispensed ^a	Doses inhaled	Doses wasted	Estimated cost of wasted doses
Albuterol (<i>Ventolin</i>) ^b	1,860	37	1,823 (98%)	\$580
Ipratropium (<i>Atrovent</i>) ^c	—	—	—	—
Tiotropium (<i>Spiriva</i>)	1,915	836	1,079 (56%)	\$17,488
Formoterol (<i>Foradil</i>)	144	39	105 (73%)	\$267.31
Fluticasone (<i>Flovent</i>)	2,760	52	2,708 (98%)	\$3,858.5
Budesonide/Formoterol (<i>Symbicort</i>)	10,080	675	9,405 (93%)	\$41,021
Fluticasone/Salmeterol (<i>Advair</i>)	3,038	918	2,120 (70%)	\$23,758
Total	19,797	2,557	17,240 (87%)	\$86,972.51

^aEach dose is equivalent to one inhalation unit. Per our hospital formulary, inhalers are dispensed as multidose MDI/DPI as follows: albuterol = 60 inhalations; ipratropium = 120 inhalations; tiotropium = 5 inhalation capsules; formoterol = 12 inhalation capsules; fluticasone = 120 inhalations; budesonide/formoterol = 60 inhalations; fluticasone/salmeterol = 14 inhalations.

^bThe majority of patients (97%) included in the study received nebulized albuterol (total doses = 8,081) ± ipratropium (total doses = 6,755).

^cPer our hospital policy, all orders for ipratropium MDI are interchanged to tiotropium, which may explain that no ipratropium doses were dispensed.

care system in Michigan, a generic preprinted label was added to the Cerner patient barcode label. The label was placed on a clear resealable plastic bag, and the inhaler was placed in the bag. Our understanding is that state boards of pharmacy across the United States require prescription drugs to be labeled appropriately upon initial dispensing or relabeled for a patient to take home at discharge. We are not sure whether this requirement emanates from The Joint Commission or the National Association of Boards of Pharmacy.

Other institutions have utilized a common MDI canister approach by using a single metered dose inhaler canister to administer medication to multiple patients. Advocates of this approach cite significant cost savings, staff efficiency, and fewer treatment delays, while opponents maintain that such benefits are not outweighed by the potential (although slight) risk of cross-contamination if the decontamination protocol is not followed.¹⁶⁻¹⁹ In 2009, the Institute for Safe Medication Practices commented on the common canister approach but did not provide definite recommendations, suggesting only careful decontamination protocol development and strict adherence to the protocol.²⁴ Another approach to resolve this problem includes the development of unit dose institutional inhalers. However, at this time, only a limited number of unit dose inhaler products are available in

the market and further assessment of the cost-savings associated with this approach is warranted.

Our study included patients with a primary diagnosis of COPD exacerbation. Further assessment of inhaler waste in patients with a primary diagnosis of asthma exacerbation or patients maintained on inhalers while hospitalized is needed. Limitations to our study include the fact that it is retrospective. The results of our study may have been impacted by any lack of administration documentation and may not have accounted for all missing dosages. Also, the hospital cost of the inhalers utilized to assess the waste was based on the cost at the time the analysis was done; the hospital cost of inhalers may have fluctuated during the study period.

CONCLUSIONS

Our study identified substantial waste of inhaled medications. Practical strategies are needed to reduce wasted inhalers. Further assessment of this costly problem is needed in other US hospitals.

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