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Stop using the flotation technique and start weighing salbutamol pressurised metered-dose inhalers without dose counters

Ermindo R. Di Paolo[a], Stéphanie Spaggiari[a], André Pannatier[a], Farshid Sadeghipour[a], Isabelle Rochat[b], Gaudenz M. Hafen[b]

[a] Department of Pharmacy, Lausanne University Hospital, Switzerland

[b] Respiratory Unit, Department of Paediatrics, Lausanne University Hospital, Switzerland

Summary

Salbutamol pressurised metered-dose inhalers (pMDIs) are not equipped with dose counters outside the USA. The aim of this study was to describe a simple reproducible method for determining the number of doses remaining in a pMDI based on scale weight. With a laboratory scale, the mean weight of the canisters was 28.61 ± 0.10 g after priming and 14.84 ± 0.23 g after 200 puffs. Similar results were obtained with two common digital scales. We recommend weighing salbutamol canisters on a common digital scale, and replacing an old pMDI with a new one when the weight falls to ≤15 g.

Introduction

Pressurised metered-dose inhalers (pMDIs) are devices used to administer inhaled medications. Patients with asthma or chronic obstructive pulmonary disease are often prescribed pMDIs containing a beta-adrenergic receptor agonist, such as salbutamol. These pMDIs are not generally equipped with a dose counter outside of the USA. Therefore, given the life-saving potential of these pMDIs, discovering that the device is empty when needed is intensely dangerous. Indeed, 25% of surveyed patients reported having attempted to use an empty pMDI during an asthma exacerbation [1].

There are several techniques for estimating the number of remaining doses in a pMDI; however shaking, spraying, and flotation are not reliable [1–5]. The flotation technique (i.e. immersion in water to determine amount of remaining drug) is currently forbidden by the manufacturer GlaxoSmithKline for two reasons. Firstly, the technique, which was developed with inhalers that were loaded with chlorofluorocarbon propellant gas, is not accurate with newer inhalers that are loaded with a hydrofluoroalcan propellant. Secondly, immersion in water compromises the impermeability of the pMDI valve. Although the manufacturer's instructions tell the user to count every dose, this expectation is not practical for a drug that is not administered on a regular basis.

The aim of this work was to describe a simple, reproducible method for determining the remaining doses in a salbutamol pMDI based on the weight of the canister. Accuracy of weighing was compared between a laboratory scale and two common digital scales.

Methods

Sixty salbutamol pMDIs (GlaxoSmithKline) containing 200 doses with ≥5% overfill were bought in six European countries (10 pMDIs, with two source batches per country), including France (Ventoline®), Germany (Sultanol®), Italy, Spain, Switzerland and the United Kingdom (Ventolin®). A laboratory scale (Mettler Toledo XP204®) was used to weigh the canisters. Weights were also obtained with a digital kitchen scale used in our hospital (Ohaus CS 5000®) and one marketed for home use (IKEA Ordning®). Each new pMDI was primed by releasing two puffs into the air. The canisters were weighed immediately after 50, 100, 150, 190 and 200 puffs, with a 30-second inter-puff interval. The mean weights of the canisters measured on the three scales were compared using a simple linear correlation test (Instat, Graphpad).

Results

The mean weights of the salbutamol canisters measured with each of the three different scales after priming, and 50, 100, 150, 190, and 200 puffs are reported in table 1. There was a linear correlation between the mean weights of the canisters measured on the three scales ($r = 0.998$, $p < 0.0001$). Based on the results, a practical table was produced to determine whether pMDIs are empty or close-to-empty (table 2).

Discussion

Salbutamol pMDIs produced in most countries outside of the USA are not equipped with a dose counter. The present study produced a weight-remaining dose correlation that can be used to determine the number of remaining doses in

a pMDI. The table was produced primarily to help healthcare workers in hospitals, clinics, and pharmacies assist patients in assessing how many doses remain in their pMDIs; however the method could also be used by patients themselves at home after thorough instruction.

The limitation of this study is that the results apply specifically to salbutamol pMDIs made by GlaxoSmithKline in Europe. Moreover, the manufacturer should warn health professionals if the formulation or filling of their pMDIs is changed.

In conclusion, as long as manufacturers neglect to equip all pMDIs with a dose counter, we recommend that the number of doses remaining in salbutamol pMDIs being checked by weighing the pMDIs on a common digital scale. Our results indicate that the canister should be replaced when its weight falls to ≤15 g.

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Correspondence: *Dr. Gaudenz Hafen, Department of Paediatrics, Respiratory Unit, Lausanne University Hospital CHUV, Rue Bugnon 46, CH-1011 Lausanne, Switzerland, gaudenz.hafen[at]chuv.ch*

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Table 1: Weight of salbutamol canisters (n = 60) in relation to doses remaining across three different scales.

	Mean weight (g)		
Remaining doses	**Mettler Toledo XP204 (laboratory scale)**	**Ohaus CS 5000 (ward scale)**	**Ikea Ordning (kitchen scale)**
200	28.61 ± 0.10	29	29
150	25.16 ± 0.13	25	25
100	21.72 ± 0.17	22	22
50	18.28 ± 0.20	18	18
10	15.54 ± 0.22	16	16
0	14.84 ± 0.23	15	15

Mettler, Ohaus, and Ikea scales rounded weight to nearest 0.01 g, 1 g, and 1 g, respectively.

Table 2: Practical table to determine if the canisters of the salbutamol pressurised metered-dose inhalers are empty.

Does my pressurised metered-dose inhaler still contain salbutamol?			
Weight of canister	Drug remaining?	Remaining doses	
29 g	Yes, it is full	200	
25 g	Yes, it is 3/4 full	150	
22 g	Yes, it is 1/2 full	100	
18 g	Yes, it is 1/4 full	50	
≤15 g	No, it is empty	0	