The Excessive Carbon Footprint of Inhalers Used in Airway Disease and its Remedies

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TITLE: The excessive carbon footprint of inhalers used in airway disease – and its remedies

Short title: Carbon footprint of inhalers

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- Dr Desy has no conflict of interest
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ABBREVIATIONS

CFC : chlorofluorocarbons

COPD : chronic obstructive pulmonary disease

DPIs : dry powder inhalers

GHG : greenhouse gases

HFC : hydrofluorocarbon

HFO : hydrofluoroolefin

pMDIs : Pressurised metered dose inhalers

SABA : short-acting bronchodilator

SMIs : soft mist inhalers

ABSTRACT

This clinical review discusses the environmental impacts of inhalers and possible ways to optimize their use. Pressurised metered dose inhalers (pMDIs) used in respiratory diseases, like asthma and COPD, represent 0.03% of the annual worldwide carbon footprint [1]. They constitute a healthcare risk by decreasing air quality which as a result increases symptoms and exacerbations of pulmonary diseases. Beyond pMDIs, many different types of inhalers with distinctive delivery mechanisms are available. When comparing inhaler types, one can notice that DPIs and soft mist inhalers (SMIs) have a carbon footprint approximately 10 times lower compared to pMDIs [2]. The choice of inhalers depends on a multitude of factors including personal preference, price, inhalation technique and simplicity, as well as their carbon footprint. The regulation of propellant with everyday efforts to reduce respiratory disease can lead in a reduction of green gaz emission.

INTRODUCTION

The human carbon footprint is a conversational topic worldwide. Many fields, including healthcare, have attempted to reduce their carbon footprint. For example, 4.6% of the Canadian greenhouse gases (GHG) are generated by healthcare institutions [3], ranking it second worldwide [4]. When it comes to the accountable parties, the treatments for asthma and chronic obstructive pulmonary disease (COPD) are the main contributors. These highly prevalent diseases affect respectively 11% and 10% of the Western populations [5].

Impacts of pressurised metered dose inhalers

Pressurised metered dose inhalers (pMDIs), used in respiratory diseases like asthma and COPD, represent 0.03% of the annual worldwide carbon footprint [1]. In 1987, a total of 197 countries signed the Montreal

Protocol regarding the utilisation of many substances affecting the ozone layer. Chlorofluorocarbons (CFC) contained in pMDIs were one of the substances on the treaty due to its environmental effects. Following this historical pact, CFC were replaced by hydrofluorocarbon (HFC) which had potentially fewer consequences on global warming. However, they remain important contributors for GHG emissions [6]. HFCs are synthetic gases used as a substitute for ozone-depleting substances, but also contribute to GHG emissions [7]. For instance, a single dose from a pMDI releases the same amount of carbon dioxide as driving two kilometres with a hybrid vehicle [2].

Alternatives to pMDIs-HFC

Beyond pMDIs, different types of inhalers with distinctive delivery mechanisms are available on the market. Dry powder inhalers (DPIs) utilise peak inspiratory flow to deliver the medication within the respiratory tract without the use of propellants. Comparing inhaler types on the market, one can notice that DPIs and soft mist inhalers (SMIs) have a carbon footprint approximately 10 times lower compared to pMDIs [2]. However, more than 70% of inhalers sold to adult patients are pMDIs [8]. When the inhalation technique with DPI is adequate, its efficacy parallels pMDIs and has a much lower impact on the environment [9]. In a recent study, patients using pMDIs were switched to DPIs resulting in reducing their carbon footprint by more than half with no impact on their disease control [10]. If 5% of patients, per year, substituted their pMDIs to DPIs, a reduction of 27% of GHG related to inhalers over the course of 10 years would be seen [11].

There are many factors to consider when prescribing inhalators. For example, the therapeutic efficacy of DPIs will be lower for individuals with advanced pulmonary disease due to inadequate drug delivery. Indeed, with inspiratory muscle weakness and associated pulmonary hyperinflation, the maximal inspiratory pressure is insufficient for dry powder inhalation [12]. Additionally, it can be difficult for

patients to inhale properly during an acute airway attack. Personal preference and the varying costs of inhalers must also be considered. Nevertheless, in a study comparing costs, device handling and the environmental impact of the inhalers, only 14% of the participants indicated that carbon footprint was not a decisional factor in the choice of inhalers [13].

An established diagnosis for prescribing or renewing treatment

A formal diagnosis asthma or COPD with objective tests is crucial. Unfortunately, 33% of patients receiving a presumed diagnosis for asthma within the last 5 years had no evidence of the disease during the pulmonary function test. Of those individuals, 79% used inhalers and thus contributed to the ecological damages caused by HFCs [14].

The overlooked inhaler technique

Aside from considering a substitution from pMDIs to DPIs and/or SMIs, it is crucial to educate patients in proper inhaler technique since most GHG emissions are produced during the inhalation phase [7]. When choosing a pMDI, the use of a spacer allows for the optimal medication quantity without wasting and overutilisation. This also reduces the number of inhalers used yearly, which decreases GHG. An estimated 68% of patients use their inhalers improperly, with most of them not receiving adequate education on the proper techniques [15]. Also, it is often challenging to determine if the pMDIs are empty with the absence of a numerical dial indicating the number of remaining doses. In contrast, a dial is present on most DPIs devices. Studies have shown that 40% of patients use empty inhalers, which contributes to poor control of their COPD or asthma [16]. Conversely, some patients tend to renew their inhalers prior to finishing all the doses, which increases product waste and overutilisation. In summary, it is important to educate patients on the use of inhalers, identify poor symptom control, and discuss strategies to prevent exacerbations to limit GHG.

Controlling asthma to control GHG emissions

The impact of inadequate asthma control must not be underestimated, both in terms of morbidity and carbon footprint. Compared to patients with adequate control of their disease, poorly controlled airway disease is associated with 3-fold greater GHG emissions [17]. An ideal way of maintaining proper disease control is to limit tobacco use and allergens expositions, but also to verify treatment use and inhalation technique. Furthermore, guidelines from GINA recommend that patients 12 and up with well-controlled asthma be treated with budesonide-formoterol inhalers (usually a DPI) instead of a daily inhaled corticosteroid paired with a short-acting bronchodilator (usually pMDIs) [18]. Well-controlled airway disease requires less reliever use effectively reducing the associated carbon footprint.

Returning inhalers to the local pharmacist

The carbon footprint associated with the manufacturing and disposal of pMDIs represents 30% of its total footprint [8]. The incineration and recycling of the devices reduces the impact on global warming [7]. To this day, no systematic recycling or packaging program has been implemented. Some pharmacies have decided to facilitate the recycling and disposal by encouraging their clients to return their inhalers after use. They, in turn, dispose of the devices adequately [19].

Awareness

Educational programs for patients and healthcare professionals exist to promote an eco-friendly approach. CASCADE is an organisation funded by the Canadian Government partnering with the Canadian Thoracic Society, which is similar to its counterpart PrescQIPP.info in the United-Kingdom. These programs aim to guide the healthcare systems towards a more durable environment with a neutral carbon use. To reach

their objectives, they offer multiple resources explaining how to reduce carbon emissions. These include videos on inhalation techniques, information posters and letters explaining the proper use of inhalers [20].

Regulations

Regulation can limit the use of polluting gases as witnessed in the Montreal Protocol. In addition to the efforts put in since 1987, the Kigali amendment created in 2019 aims to further reduce carbon emissions. It consists of imposing a mandated reduction of HFC worldwide [6]. Hydrofluoroolefins (HFOs) are currently in development to assure an alternative pMDIs propellant [21]. Replacing HFC with HFOs would substantially reduce the global warming potential of pMDIs.

CONCLUSION

In conclusion, healthcare systems must take part in reducing their carbon footprint. This is especially true for airway disease and its associated inhalers (Figure). pMDIs constitute a healthcare risk by decreasing air quality and as a result increase symptoms and exacerbations of pulmonary diseases. The choice of inhalers depends on a multitude of factors including personal preference, price, inhalation technique and simplicity, as well as their carbon footprint. Efforts have been made to reduced GHG emissions with the CASCADE and PrescQIPP.info, recycling programs in pharmacies, the Kigali amendment aiming to progressively reduce the HFC and developing new alternatives to the propulsion mechanism with HFO.

FIGURE

The excessive carbon footprint of inhaler devices used in airway disease – and its remedies. GHG, greenhouse gas; COPD, chronic obstructive pulmonary disease.

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4,6% of **GHG** are attrubuted to the healthcare system

Step 1

Inform the population and healthcare professionals

Poorly controlled asthma produces **3x** more **GHG** compared to stable asthma

Step 2

Optimization of disease control

Pressurised metered dose inhalers produces **10x** more **GHG** compared to a dry powder inhalers

Step 3

Prioritize dry powder inhalers

The manufacturing and disposal of the pMDI = **30%** of the **GHG**

Step 4

Dispose and recycle the inhalers in ecofriendly ways