Carbon footprint impact of the choice of inhalers for asthma and COPD

Christer Janson,1 Richard Henderson,2 Magnus Löfdahl,3 Martin Hedberg,4 Raj Sharma,5 Alexander J K Wilkinson6

ABSTRACT

In the 1990s, metered dose inhalers (MDIs) containing chlorofluorocarbons (CFCs) as propellant were the most common way to administer inhaled therapy for asthma and chronic obstructive pulmonary disease (COPD). In 1987, the Montreal Protocol on Substances that Deplete the Ozone Layer included the phasing out of CFCs,1 warranting the development of new ways to deliver inhaled therapy for asthma and COPD. This included dry-powder inhalers (DPIs), CFC-free MDIs that used hydrofluorocarbons (HFCs) as a propellant and, aqueous/soft mist inhalers. Studies of prescription patterns in Europe have found large differences among countries in choice of inhalation device. A study published in 2011 concluded that approximately 90% of inhaled corticosteroid (ICS) devices used in Sweden were DPIs, whereas in the UK, approximately 80% were MDIs.2

Unlike CFCs, HFCs are not ozone-depleting substances but they are still greenhouse gases that have a high global warming potential (GWP). In 2017, the British Thoracic Society issued a statement to encourage prescribers and patients to consider switching pressurised MDIs to non-propellant devices because of this difference in environmental impact. This statement was recently updated.3 This study aimed to compare the environmental impact of DPI and MDI combinations using calculated carbon footprint data for two DPIs, Ellipta and Accuhaler, and one MDI, Eolovaler. A secondary aim was to compare the inhaler-related carbon footprint impact between England and Sweden and the potential for reduction of annual carbon footprint (CO2e) in England if the pattern of inhalation devices chosen in England were to resemble that in Sweden.

INTRODUCTION

Until the early 1990s, metered dose inhalers (MDIs) that contained chlorofluorocarbons (CFCs) as propellant were the most common way to administer inhaled therapy for asthma and chronic obstructive pulmonary disease (COPD). In 1987, the Montreal Protocol on Substances that Deplete the Ozone Layer included the phasing out of CFCs,1 warranting the development of new ways to deliver inhaled therapy for asthma and COPD. This included dry-powder inhalers (DPIs), CFC-free MDIs that used hydrofluorocarbons (HFCs) as a propellant and, aqueous/soft mist inhalers.

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Unlike CFCs, HFCs are not ozone-depleting substances but they are still greenhouse gases that have a high global warming potential (GWP). In 2017, the British Thoracic Society issued a statement to encourage prescribers and patients to consider switching pressurised MDIs to non-propellant devices because of this difference in environmental impact. This statement was recently updated.3 This study aimed to compare the environmental impact of DPI and MDI combinations using calculated carbon footprint data for two DPIs, Ellipta and Accuhaler, and one MDI, Eolovaler. A secondary aim was to compare the inhaler-related carbon footprint impact between England and Sweden and the potential for reduction of annual carbon footprint (CO2e) in England if the pattern of inhalation devices chosen in England were to resemble that in Sweden.

RESULTS

The Eolovaler MDIs had 20–30 times larger carbon footprints than the Accuhaler and Eolovaler DPIs (table 1). This difference was mainly related to the use phase (treatment) and the end of life phase (disposal) when the propellant is released.

The combination of Relvar Ellipta (9.5 kg CO2e) and Ventolin Accuhaler (7.3 kg CO2e) had an annual carbon footprint of 17 kg CO2e, while the corresponding value for using the combination Seretide Eolovaler (234 kg CO2e) and Ventolin Eolovaler (205 kg CO2e) was 439 kg CO2e (figure 1).

In England in 2017, 70% of all inhalers sold were MDIs, whereas the corresponding figure for Sweden was 13%. The difference was largest for SABA: 94 versus 10% MDIs in England and Sweden respectively, while the corresponding difference for devices that contained ICS was 62 versus 14%.
Table 1  Contribution of phases in the life cycle of different inhaler devices to their individual carbon footprint (net kg CO2e/per pack) and annual carbon footprints of each device

<table>
<thead>
<tr>
<th>Device</th>
<th>Active pharmaceutical ingredients</th>
<th>Manufacturing</th>
<th>Distribution</th>
<th>User phase</th>
<th>End of life</th>
<th>Net kg CO₂e/pack</th>
<th>Net kg CO₂e/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELVAT ELLIPTA 92/22 µg</td>
<td>0.02</td>
<td>0.73</td>
<td>0.03</td>
<td>0.00</td>
<td>0.03</td>
<td>0.80</td>
<td>9.5</td>
</tr>
<tr>
<td>SERETIDE ACCUHALER 50/500 µg</td>
<td>0.25</td>
<td>0.46</td>
<td>0.06</td>
<td>0.12</td>
<td>0.02</td>
<td>0.90</td>
<td>11.0</td>
</tr>
<tr>
<td>VENTOLIN ACCUHALER 200 µg</td>
<td>0.02</td>
<td>0.42</td>
<td>0.06</td>
<td>0.12</td>
<td>0.02</td>
<td>0.60</td>
<td>7.3*</td>
</tr>
<tr>
<td>SERETIDE EVOHALER 25/250 µg</td>
<td>0.08</td>
<td>2.12</td>
<td>0.02</td>
<td>10.68</td>
<td>6.08</td>
<td>19.00</td>
<td>234.0</td>
</tr>
<tr>
<td>VENTOLIN EVOHALER 100 µg</td>
<td>0.10</td>
<td>1.11</td>
<td>0.02</td>
<td>19.39</td>
<td>7.38</td>
<td>28.00</td>
<td>205.0*</td>
</tr>
</tbody>
</table>

*If using on average two doses per day.

If England had the same rates of MDI use as Sweden, 550 kt CO₂e would be saved annually (table 2).

**DISCUSSION**

Using Ellipta and Accuhaler DPIs instead of E loophaler MDIs resulted in an annual carbon footprint reduction equivalent to 422 kg CO₂e per patient. Applying the Swedish DPI and MDI distribution to England would result in an estimated annual reduction of 550 kt CO₂e annually.

The impact of HFCs from inhalers on overall greenhouse gas emissions can be viewed from many perspectives. Internationally, HFC release from MDIs in 2014 was equivalent to 0.013 gigaton CO₂e, which was about 3% of global GWP-weighted CO₂e emissions of HFCs.1 HFCs are also used as refrigerants in refrigeration, air-conditioning and heat pump equipment (80%); as blowing agents for foams (11%); as solvents and in fire extinguishers (5%). From an individual patient’s perspective, a comparison of Ventolin and Seretide E loophalers with Relvar Ellipta and Ventolin Accuhaler could save 422 kg CO₂e per year per patient. This is similar to the per capita carbon reductions obtained if changing from a meat-based to a plant-based diet.5 The calculation was based on a usage of two doses SABA per day.6 In patients that are very well controlled and therefore not using any SABA at all the difference was 234 kg CO₂e per year.

We found a large difference between England and Sweden in the distribution of inhalation devices. This is in accordance with previous data.2 The reason for this difference is not entirely clear but could be related to marketing strategies and prescribers’ and patients’ biases.2 In England, the carbon footprint of the National Health Service (NHS) is ≈23 mt CO₂e. Pharmaceuticals procurement is 16% of the footprint, one quarter of which comes from MDIs.5 Other carbon footprint sources include building and energy and travel (4.6 and 2.8 mt CO₂e, respectively). The predicted reduction of 550 kt CO₂e annually that we calculated by applying the Swedish distribution of inhalation devices to the population in England thus corresponds...
Analysis uses 2017 community prescribing data from the NHS in England (https://digital.nhs.uk/) and assumes carbon footprint of MDI is 20 kg CO\textsubscript{2}e and DPI is 1 kg CO\textsubscript{2}e. SAMA not included in analysis, as no DPI SAMA alternative is available. Potential annual reduction shows the hypothetical carbon savings if England were to prescribe the same proportions of MDI as Sweden.

DPI, dry powder inhaler; ICS, inhaled corticosteroid; LABA, long-acting \(\beta\)-agonist; LAMA, long-acting muscarinic antagonist; MDI, metered dose inhaler; SABA, short-acting \(\beta\)-agonist; SAMA, short-acting muscarinic antagonist.

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ORCID iDs Christer Janson http://orcid.org/0000-0001-5093-6980 Alexander J K Wilkinson http://orcid.org/0000-0002-1808-3663

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