PrescQIPP
Community Interest Company

Inhaler carbon footprint

Recommendations

- Determine how local or practice prescribing data on the inhaler carbon footprint compares to the national or local average and identify where local improvements can be made using the PrescQIPP inhaler carbon footprint data tool and visual data pack.
- Agree, through an appropriate group such as the Area Prescribing Committee, a range of strategies to support the NHS commitment to lower the inhaler carbon footprint.
- Agree medicines optimisation strategies to lower the inhaler carbon footprint which optimise prescribing by:
  - Getting or maintaining good control of asthma and COPD through reviewing patients regularly and treating in line with NICE asthma and COPD treatment pathways.
  - Agreeing local respiratory pathways and medicines formulary choices which take into account lower inhaler carbon footprint options.
  - Demonstrating and checking inhaler technique.
  - Identifying and reducing short-acting beta-2 agonist (SABA) overuse.
  - Changing to combination inhalers where clinically appropriate.
  - Prescribers discussing, with individual patients, lower carbon footprint inhalers during patient reviews or when a change in treatment is clinically necessary.
- Support prescribers to start new patients on, or switch existing patients to, lower carbon inhaler alternatives. Examples of support include:
  - Prescriber education on lowering the inhaler carbon footprint.
  - Providing practice level inhaler carbon footprint prescribing data.
  - Producing local respiratory prescribing guidelines which include lower carbon footprint inhalers and how to optimise prescribing.
  - Ensuring lower carbon footprint inhaler options are included in medicines formularies.
  - Providing examples of locally preferred switches from high to lower carbon footprint inhalers.
  - Undertaking audits to identify respiratory patients suitable for review to improve clinical outcomes and reduce the inhaler carbon footprint.
  - Providing patient information resources to explain the change to low carbon footprint inhalers.
  - Ensuring stock availability of any alternative inhaler switches locally recommended through discussions with pharmacies, suppliers and/or manufacturers.
- Reduce the environmental impact of inhaler waste by:
  - Encouraging patients to return their used or unwanted inhalers to a pharmacy for either recycling where available or environmentally safe disposal.
  - Encouraging patients to look after their inhalers and not over-order.
  - Ensuring that patients know how to tell when their inhaler is empty.
  - Increasing the use of re-usable inhalers.

Background

Across England, Wales and Scotland 61.1 million inhaler items are prescribed annually with a total carbon footprint of 1,342,923,023 kg CO_2e (NHSBSA Apr-June 21). Pressurised metered dose inhalers (pMDIs) account for 71.6% of all inhaler device types prescribed in England, 68.8% in Wales and 66.6% in Scotland (NHSBSA Apr-Jun 21). The UK pMDI use is higher than the rest of Europe (<50%) and Scandinavia (10–30%).[1]

Chlorofluorocarbon (CFC) propellants contained in pMDIs were recognised as ozone depleting substances and their production was phased out in the UK by 1996. CFCs were replaced by so-called 'CFC-free' inhalers containing hydrofluorocarbons (HFCs). Although HFCs are not ozone depleting substances, they are powerful greenhouse gases which can contribute to global warming.[2,3] Carbon emissions from inhalers have been assessed as responsible for approximately 3% of all NHS carbon emissions. The majority of emissions come from the propellant in pMDIs used to deliver the medicine rather than the medicine itself.[4]

Two hydrofluoroalkane (HFA) propellants are currently used in pMDIs: 1,1,1,2-tetrafluoroethane (HFA-134a) and 1,1,1,2,3,3,3-heptafluoropropane (HFA-227ea). These have been identified as having a high global-warming potential (GWP).[5] The carbon footprint impact of two puffs of a salbutamol pMDI has been estimated as 500 g CO_2e. The carbon footprint of a nine mile car journey is estimated as 2610 g CO_2e in comparison.[3,6] The availability of pharmaceutical grade hydrofluorocarbons will decrease with a reduction in other applications and so costs of the propellants are likely to increase in time. pMDIs will remain essential in some situations and so alternative propellants with low GWP are required. One such propellant, HFC-152a, is in active development.[7] However, it is unlikely to be commercially available until the end of 2025.[8]

The NHS England Long Term Plan published in January 2019, outlined the national targets of reducing the carbon footprint of health and social care in line with the Climate Change Act targets of 51% by 2025.[9] To support this target, 'Delivering a 'Net Zero' National Health Service' outlines actions to be taken to reduce carbon emissions from inhalers. These include optimising prescribing, substituting high carbon products for low-carbon alternatives and improvements in production and waste processes.[4] These are discussed in more detail under strategies to support a reduction in inhaler carbon emissions.

To support this change, the Primary Care Network (PCN) Directly Enhanced Service (DES) specification for structured medication reviews and medicines optimisation makes a requirement of PCNs to "actively work with their CCG to optimise the quality of prescribing of metered dose inhalers, where a low carbon alternative may be appropriate".[10] In addition, the NHS England and NHS Improvement (NHSEI) Investment and Impact Fund (IIF): 2021/22 and 2022/23 contains four indicators (RESP-01, RESP-02, ES-01, ES-02) to support the dual outcomes of (i) improved respiratory care and health outcomes for people with an asthma diagnosis (ii) delivering the NHSEI and British Medical Association (BMA) ambitions to reduce avoidable carbon emissions through encouraging choice of lower carbon inhaler alternatives, where clinically appropriate and to improve respiratory care and health outcomes for people with asthma.[11]

Data on the carbon footprint impact of inhalers available in the UK is needed to support the development of strategies for lowering the inhaler carbon footprint impact across NHS organisations and to review progress against this objective. In this bulletin, data on the carbon impact of inhalers from a literature review is provided, as well as information obtained from a survey of inhaler manufacturers on the carbon impact for the lifecycle of their inhalers. The data from the pharmaceutical industry is generated by them, some of which has been certified by The Carbon Trust. This data was used to produce a referenced list of carbon footprint values for inhalers available in the UK, see attachment 1 - Inhaler carbon footprint data. Although the methods used to produce this data differ, the inhaler carbon footprint data is useful for comparing the relative differences between inhalers and for producing strategies to support a reduction in the overall inhaler carbon footprint.

National guidance

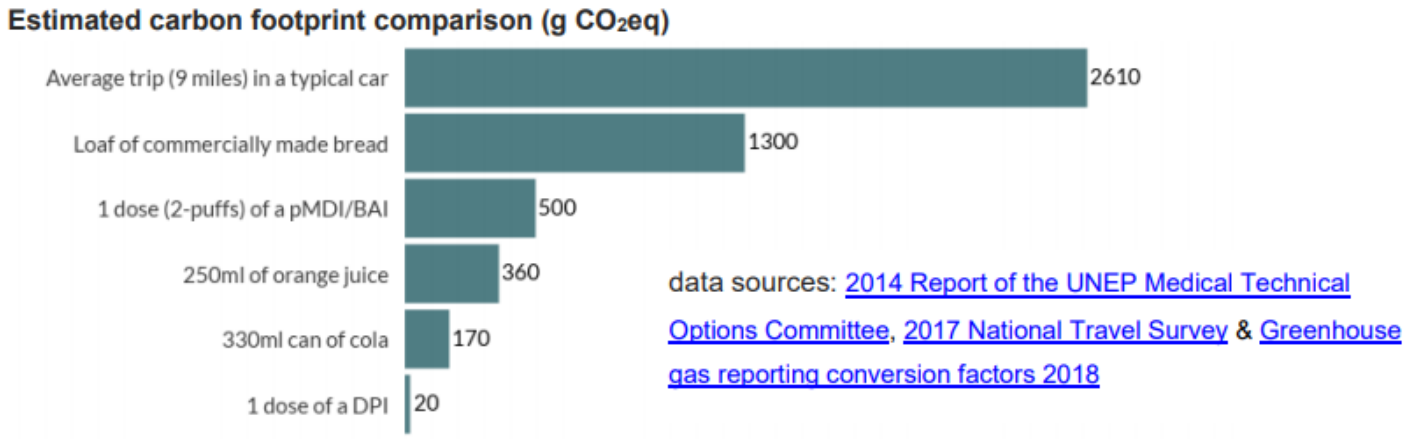
The British Thoracic Society (BTS)/Scottish Intercollegiate Guidelines Network (SIGN) British guideline on the management of asthma 2019 recommends that prescribers, pharmacists and patients should be aware that there are significant differences in the global warming potential (GWP) of different pMDIs and that inhalers with low global-warming potential should be used when they are likely to be equally effective. Where there is no alternative to pMDIs, lower volume HFA-134a inhalers should be used in preference to large volume or HFA-227ea inhalers.[12] Refer to attachment 1 for propellant and volume information for inhalers available in the UK.

The National Institute for Health and Care Excellence (NICE) has produced a patient decision aid to help people with asthma, alongside health professionals, identify which inhalers could meet their needs and control their symptoms and gives instructions on how to use them. NICE state that pMDIs contain propellants known as hydrofluorocarbons (HFCs), powerful greenhouse gases, which propel the dose into the patient's respiratory system. However, many people will be able to achieve the same benefit from DPIs. DPIs have lower estimated carbon footprints of 20 g CO_2e per dose (two puffs) compared to pMDIs which are estimated at 500 g CO_2e per dose (two puffs). NICE encourages the use of lower carbon impact inhalers, but emphasises that people who need to use a pMDI should continue to do so. Soft mist inhalers (SMIs) were not included in the patient decision aid because there was only one medicine available for asthma in this device. NICE do state, within the patient decision aid, that SMIs do not contain a propellant, so they have a lower carbon footprint than pMDIs.[3,6,13]

The NICE inhalers for asthma patient decision aid includes an explanation of what is meant by the carbon footprint of inhalers and provides information that breath actuated inhalers (BAI) or pMDIs have a higher carbon footprint compared to DPIs.

To support patient understanding, the estimated carbon footprint of one dose (two puffs) of a pMDI is compared to everyday things such as an average nine miles trip in a typical car, 250ml of orange juice, a 330ml can of cola and one dose of a dry powder inhaler (DPI), see Figure 1.[3,6]

Figure 1. NICE inhalers for asthma patient decision aid estimated carbon footprint comparison (g CO_2 eq)



Where several inhalers are suitable, NICE suggests that patients can choose a lower carbon emission option if they prefer and so contribute to lowering the NHS carbon footprint.[3,6]

The NICE inhalers for asthma patient decision aid also compares whether the different type of inhalers can be recycled. Patients are referred to the 'Recycle Now' website for more information on safe recycling of medicines.[3] The 'Recycle Now' website advises that all used inhalers should be returned to a pharmacy to be disposed of by the pharmacist with other drugs waste, which is thermally treated to destroy the greenhouse gases.[14]

Inhaler carbon emissions data by inhaler

Information on the carbon impact of individual inhalers is not readily available in typical reference sources used by healthcare professionals, such as the British National Formulary (BNF), Monthly Index of Medical Specialties (MIMS) or the Summary of Product Characteristics (SPC).[15-17] Currently, there is no complete list of the carbon footprint for inhalers available in the UK. Having this information would enable identification of low and high carbon footprint value inhalers and so support the development of strategies across health economies to reduce the inhaler carbon footprint.

The Carbon Trust and Association of British Pharmaceutical Industry have developed a blister pack carbon footprint tool which can be used to provide a quick approximation of the carbon impacts of pharmaceutical tablets in blister packs. However, this has not been designed for use for inhalers.[18]

Inhaler carbon emissions data in the literature

Attempts to produce inhaler carbon footprint values have been reported in the literature. Different approaches have been taken to calculate the carbon footprint impact of inhalers, some have focused on the propellant impact only whilst others have looked at the carbon impact through the lifecycle of the inhaler from production to disposal. The propellant itself is responsible for the majority of the carbon impact of pMDIs and so is a good indicator, but a complete analysis of the lifecycle of the inhaler would provide more detailed information.

The whole product lifecycle carbon footprint of Clenil® (beclometasone dipropionate) pMDI, Fostair® (extrafine beclometasone/formoterol) pMDI, Fostair® NEXThaler DPI, and Trimbow® (extrafine beclometasone/formoterol/glycopyrronium) pMDI were calculated using a systematic approach for carbon footprint calculation (CF-SA) based on both the ISO 14067–2018 standard and guideline 'Greenhouse Gas Accounting Sector Guidance for Pharmaceutical Products and Medical Devices' released for the pharmaceutical sector by the NHS in the UK. This facilitates the calculation of the carbon footprint of multiple products within the same organisation, as long as they have the same scope, in terms of datasets and allocation modes. The purpose of the CF-SA is the creation of a certified system through which an organisation can independently create and register the carbon footprint of products, without the need to certify the individual carbon footprint from time to time by a third party. The CF-SA also allows the assessment of the carbon footprint of products already in the development phase, supporting appropriate design considering also environmental impact. The carbon footprint for the selected pMDI products were found to range from 82 to 119 g CO_2e/actuation, while for the DPIs it was 8 g CO_2e/actuation.[19] Detailed analysis of the contribution to their individual carbon footprint of the different phases in the life cycle (from 'cradle to grave' (CTG)) of Fostair® pMDI and Fostair® NEXThaler DPI product showed that the carbon footprint impact was greatest for in-use, 94.42 g CO_2e/actuation for Fostair® 100/6 pMDI and 7.63 g CO_2e/actuation for Fostair® NEXThaler 100/6 DPI.[19] These values are in line with those submitted by the manufacturer for the inhaler carbon footprint survey data included in attachment 1.

The carbon footprints of tiotropium bromide (Spiriva®) Respimat® (both disposable and reusable devices) and ipratropium bromide (Atrovent®) HFA pMDI were assessed across their whole life cycle (material acquisition and pre-processing, production, distribution, use and end of life) in a study funded by Boehringer Ingelheim. Primary data were collected from relevant members of the supply chain via email using customised data collection templates. Returned data were cross-checked for completeness and plausibility using mass balance (accounting for material entering and leaving the system), stoichiometry (where the total mass of the reactants equals the total mass of the products) and internal/external benchmarking. Any gaps, outliers or inconsistencies were resolved internally. Key assumptions based on estimates were made for other inputs, e.g. shipping/transport and disposal/end of life. The carbon footprints were calculated according to the Intergovernmental Panel on Climate Change Fifth Assessment Report on Climate Change, and were compliant with the Product Life Cycle Accounting and Reporting Standard and specific sector guidance for pharmaceutical products. The carbon footprints were assessed over one month of use (also three and six months for reusable Spiriva® Respimat®).

pMDI use was analysed as 6.6 actuations/day (200 actuations equivalent to one month usage). Spiriva® Respimat® use was analysed as two actuations/day; Spiriva® Respimat® cartridges are used for 60 actuations, sufficient for one month usage. The data showed that the carbon footprint of the HFA pMDI product was approximately 20 times greater than the disposable Respimat® device. Atrovent® pMDI 14.59 kg CO_2e, disposable Spiriva® Respimat® 0.78 kg CO_2e.[20] These values are in line with those submitted by the manufacturer for the inhaler carbon footprint survey data included in attachment 1.

Most of the total carbon footprint for Atrovent® pMDI was accounted for by the HFA propellant emissions during use and end-of-life phases, accounting for approximately 98% of each pMDI life cycle total for each product. The additional impact of the pMDI device (about 1%), formulation (0.8%), other materials, production process and distribution (each between 0% and 0.1%) had a minor influence on the total carbon footprint of the pMDI products. The highest contribution (about 60%) to the total carbon footprint value for the disposable Spiriva® Respimat® inhaler was for the materials used in the device and cartridge parts (stainless steel, aluminium, several polymers); around 30% of the total carbon footprint was due to the energy required in the production process of the end-of life phase (disposal of the packaging, empty cartridge and device) contributed around 8% in both cases. An additional 0.6% of the total impact was due to product distribution. The formulation had a very low impact on the total carbon footprint (around 0.1%). The use phase had no impact, as the emission of the formulation were not included in this study; it was marginal and considered to stay in the users' lungs. Paper products used for packaging contributed a negative value due to the biogenic carbon incorporated into these materials. The electricity and thermal energy used during the disposable Respimat® device cartridge assembly steps contributed more to the total carbon footprint than the energy used during the Respimat® packaging step: 0.38 and 0.08 versus 0.01 kg CO_2e, respectively. Compared with the single-use device over one month, the total carbon footprint of Spiriva® Respimat® were further reduced by 57% and 71% to 0.34 and 0.23 kg CO_2e using the device with refill cartridges over three and six months, respectively.[20]

A CTG carbon footprint analysis and Life Cycle Assessment (LCA) of four different Easyhaler® products available for the treatment of asthma and COPD (budesonide-formoterol; salmeterol-fluticasone; salbutamol, and formoterol) was conducted in 2019 using in-depth data collection from Orion in-house data, suppliers, and reference databases. Analyses were performed by ISO14001:2015 and 9001:2015 certified Carbon Footprint Ltd. The total CTG life cycle emissions for one Easyhaler® (average) was 0.588 kg CO_2e (range 0.514–0.664 kg).[21,22] These values are in line with those submitted by the manufacturer for the inhaler carbon footprint survey data included in attachment 1.

Emissions from manufacture accounted for 60% (range 54–65%). In comparison, emissions from distribution accounted for less than 2%, indicating that most potential for reductions in the carbon footprint lies in manufacture processes.[21,22]

The annual carbon footprint for the average use of Relvar Ellipta® (fluticasone furorate/vilanterol) (DPI), Seretide* Accuhaler® (fluticasone propionate/salmeterol) (DPI), Seretide Evohaler® (pMDI), Ventolin* Accuhaler® (salbutamol) (DPI), and Ventolin Evohaler® (pMDI) in asthma and COPD were estimated based on individually produced carbon footprints by GlaxoSmithKline (GSK) and certified by the Carbon Trust. (*If using on average two doses per day.) They took into account the whole life cycle of the device: production of pharmaceutical ingredients and the final product, packaging of the product, distribution and storage, use and disposal. The annual carbon footprints per patient were 9.5 kg CO_2e for Relvar Ellipta®, 7.3 kg CO_2e Ventolin Accuhaler®, 234 kg CO_2e for Seretide Evohaler® and 205 kg CO_2e for Ventolin Evohaler®. The Evohaler pMDIs had 20 to 30 times larger carbon footprints than the Accuhaler® or Ellipta® DPIs.[23] GSK has provided updated analysis undertaken by The Carbon Trust Ltd in 2020, the total CTG life cycle emission for one Ellipta® (average) was 0.75 kg CO_2e per inhaler. These figures are included in attachment 1 - inhaler carbon emissions.

Wilkinson and colleagues determined the carbon footprint for England's most commonly prescribed inhalers in 2017. The indicative amount of HFA propellant per inhaler was obtained from a combination

of studies which provided estimated weights of propellant and the inhaler patent information. The carbon footprint was estimated by multiplying the estimated weight of HFA propellant by its global warming potential (GWP).[24] These values, or methodology if the values were not included, were used to produce the data in attachment 1 on inhaler carbon emissions where this was not available from manufacturers.

Methodology used to calculate carbon emissions in the inhaler carbon emissions table (attachment 1)

A list of all inhaler devices (and the name of the manufacturer) used in asthma, COPD and other respiratory conditions in the UK was produced (attachment 1) using the BNF, MIMS, the SPC and NHS dm+d browser as references.[15-17,25] The SPC for each of these inhaler devices was reviewed for inhaler carbon emissions data and propellant information.[17] Each manufacturer was contacted and asked to complete an online questionnaire regarding the carbon emissions information they have for their inhalers. This was in a standard format with pre-defined questions and included the complete lifecycle of inhalers. Figure 2 illustrates the pre-defined questions.

Figure 2. Questions for the manufacturers survey

- Brand name; Generic name; Strength (micrograms per actuation)
- Device type
- Number of actuations per inhaler
- Propellant used
- Inhaler volume
- Total carbon footprint per actuation (g CO_2e)
- Total carbon footprint per inhaler (g CO_2e)
- Please state how the carbon footprint per actuation (g CO_2e) was calculated where this information is available
- Inhaler carbon footprint attributed to raw materials API and excipients manufacturing (including the propellant) (g CO_2e)
- Inhaler carbon footprint attributed to raw materials inhaler device components (g CO_2e)
- Inhaler carbon footprint attributed to raw materials for packaging (g CO_2e)
- Inhaler carbon footprint attributed to raw materials transportation (g CO_2e)
- Carbon footprint attributed to energy and water consumption (g CO_2e)
- Carbon footprint attributed to manufacturing waste (g CO_2e)
- Carbon footprint attributed to HF leaks and air emissions (g CO_2e)
- Carbon footprint attributed to distribution and transportation (g CO_2e)
- Carbon footprint attributed to user phase (g CO_2e)
- Carbon footprint attributed to end of life (g CO_2e)
- Carbon footprint attributed to other carbon emission data held (g CO_2e)
- Do you have plans to change to HFA-152a propellant or alternative lower GWP value propellant? If so, when do you plan to introduce lower GWP propellants in your inhalers?
- Any further information on the carbon footprint of this product

For some inhalers there are a number of different inhaler suppliers in addition to the manufacturer themselves. The transport of products would be different from suppliers and manufacturers and so the carbon footprint values attributed to transport might be different. Transport does not usually contribute a significant amount to the overall footprint of pharmaceuticals, with the exception of air freight.[18] The carbon footprint of inhalers issued through suppliers was considered to be the same as the originator manufacturer in this analysis.

Twelve out of 16 manufacturers (75%) completed the on-line survey and the information they provided has been entered in to attachment 1. For non-responders or where manufacturers had no data available, the carbon footprint values were estimated using the values and methodology reported by Wilkinson and colleagues.[24] For those inhalers which were not included in the Wilkinson paper, the summary of product characteristics were used to identify the type of inhaler (pMDI, DPI or SMI), propellant and whether ethanol was used (i.e. small or large volume inhaler) and then a carbon footprint estimate was made.

Please note this bulletin does not cover the ethanol content of inhalers. Please refer to the SPS guidance covering this subject https://www.sps.nhs.uk/articles/ethanol-content-of-inhalers-what-is-the-significance/ Check the current SPC for excipients that may be unsuitable for individuals such as ethanol and lactose.

The methodologies used by manufacturers to calculate the inhaler carbon footprint were provided. The methods varied between manufacturers and it was not possible to judge the quality of their submissions. This should be borne in mind when comparing inhaler carbon footprint data between different inhalers. However, in most cases the submitted values per actuation or per inhaler were in line with estimations from the literature currently available. There are International Organisation for Standardisation (ISO) documents available on 'Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification' already available to support this work.[26]

Manufacturers provided product lifecycle carbon footprint breakdown for 52 out of 137 inhalers. Not all submissions had data for each stage of the product lifecycle as some manufacturers had not produced the data in this format. Emerging themes were that the raw materials (which includes propellants), energy and water consumption, and user phase produced higher carbon footprint values compared to other stages of the product lifecycle.

Inhaler carbon emissions data

Attachment 1 provides a list of UK currently available inhalers and their carbon impact calculated as outlined in the methodology section above. The indicative carbon footprint per actuation (g CO_2e) and per inhaler is provided alongside the cost per inhaler. Attachment 1 indicates whether an inhaler has a high (≥35 g CO_2e per actuation) or low (<35 g CO_2e per actuation) carbon footprint. The 35 g CO_2e per actuation value was selected as this was the upper carbon footprint value for a DPI/SMI found in this analysis. This is broadly in line with the NICE inhalers for asthma patient decision aid, which describes a lower carbon footprint inhaler as 20 g CO_2e per dose. A higher carbon footprint inhaler is described in the NICE inhalers for asthma patient decision aid as one with an estimated carbon footprint of 500 g CO_2e per dose. In this analysis this figure was found at the upper end of the inhaler carbon footprint values per actuation.[3]

This information, alongside the information under "Strategies to support a reduction in inhaler carbon emissions", may be used to support the development of strategies to reduce the inhaler carbon footprint across NHS organisations. It may also be used to inform healthcare professionals and patients of the likely carbon impact of an inhaler as part of shared decision making on which inhaler is prescribed.

Strategies to support a reduction in inhaler carbon emissions

Before strategies to support a reduction in inhaler carbon emissions can be developed, organisations will need to look at their local baseline inhaler carbon emissions prescribing data. Comparing local data with the national average provides useful comparisons and also helps to identify where local improvements can be made. The PrescQIPP inhaler carbon footprint data tool and visual data pack may be used for this.

It is important to gain the agreement of key stakeholders in the development of inhaler carbon emission reduction strategies. An appropriate group, such as the Area Prescribing Committee, should be used to discuss and agree the strategy. This group may also be used to agree local respiratory pathways and medicines formulary choices which take into account inhaler carbon footprints. Support should be provided to prescribers to start new patients on or switch existing patients to lower carbon inhaler alternatives. Examples of support include:

- Prescriber education on lowering the inhaler carbon footprint
- Inhaler carbon footprint practice level prescribing data
- Local respiratory prescribing guidelines
- Low carbon inhalers included in formulary choices
- Locally preferred lower carbon inhaler switches
- Audits to identify patients suitable for an inhaler switch
- Patient information resources to explain the change to low carbon inhalers
- Ensuring stock availability of the alternative inhaler through discussions with supplies and/or manufacturers

If any new inhalers are added to the local formulary or respiratory pathways, organisations should ensure there is sufficient stock availability. A phased introduction, with manufacturer involvement if necessary, should help to prevent stock shortages and adverse impacts on patients, pharmacies and healthcare professionals. Communicating any changes to key stakeholders is very important in ensuring a smooth transition to a new inhaler formulary or respiratory pathway. A communication strategy should be included in any strategies developed.

Table 1 provides a summary of what to do and how to do it when developing an inhaler carbon footprint reduction strategy.

Table 1: Developing an inhaler carbon footprint reduction strategy

What to do	How to do it
• Look at local inhaler carbon footprint prescribing data and how this compares nationally • Identify where local improvements can be made	• Use the PrescQIPP inhaler carbon footprint data tool and visual data pack to compare local and national inhaler prescribing data • Look at the potential inhaler switches and view the local impact on inhaler carbon footprint and costs • Produce a list of potential inhaler changes which reduce inhaler carbon emissions for consideration by an appropriate prescribing group such as the Area Prescribing Committee
• Develop local respiratory formulary and pathways which enable a reduction in inhaler carbon emissions	• Discuss whether any changes to the current local respiratory formulary and pathways need to be made to support reductions in the inhaler carbon footprint at an appropriate group, such as the Area Prescribing Committee • Use the PrescQIPP inhaler carbon footprint data tool and visual data pack to view the impact on carbon footprint and costs of changing formulary inhaler choices or pathways • Plan a phased introduction, with manufacturer involvement if necessary, to help prevent any stock shortages and adverse outcomes for patients, pharmacies or healthcare professionals

What to do	How to do it
• Ensure that all key stakeholders are aware and supportive of any changes to the local inhaler formulary or respiratory pathway and inhaler carbon footprint reduction strategy	• Identify all key stakeholders • Determine their level of interest in inhaler carbon footprint emission reduction strategies • Involve key stakeholders with a high level of interest in inhaler carbon footprint emission reduction strategies, for example, through including them in Area Prescribing Committee discussions • Communicate to key stakeholders the inhaler carbon footprint emissions reduction strategy and any changes in inhaler formulary choices or respiratory pathways

Delivering a 'Net Zero' National Health Service suggest the following strategies to reduce carbon emissions from inhalers:

- Optimise prescribing
- Substitute high carbon products for low-carbon alternatives
- Improvements in production and waste processes[4]

These strategies are considered in more detail under each heading.

1. Optimising prescribing

Keeley et al suggested a number of practical options for optimising prescribing in respiratory care to reduce the environmental impact of inhalers and how to achieve them.[27] These are included in table 2.

The NICE guideline on asthma diagnosis, monitoring and chronic asthma management [NG80] suggest a leukotriene receptor antagonist (LTRA, such as montelukast tablets) should be offered in addition to low dose ICS if asthma is uncontrolled as opposed to increasing the ICS dose.[28] This will support improvements in disease control and may reduce the inhaler carbon footprint . The PrescQIPP resource on asthma considers the place of LTRAs as add on treatment to low dose ICS and also the differing recommendation from the BTS/SIGN guidance to add a LABA to low dose ICS.

The IIF RESP-01 indicator has a target for the percentage of patients on the Quality and Outcomes Framework (QOF) Asthma Register who were regularly prescribed an inhaled corticosteroid over the previous 12 months (range 71% to 90%). The IIF will reward PCNs for increasing the percentage of asthma patients who are regularly prescribed an inhaled corticosteroid (ICS, or preventative inhaler), where clinically indicated. As well as improving patient health, it is envisaged that this incentive will also enable reductions in unnecessary SABA prescribing (and therefore carbon emissions) by improving disease control.[11]

The options suggested in line with optimised prescribing initiatives are outlined in table 2 on the next page.

Table 2: Reducing the environmental impact of inhalers in respiratory care through optimised prescribing[27,28]

What to do	How to do it
• Improve asthma control and reduce use of SABA reliever inhalers	• Encourage regular preventer treatment by every means possible, empowering patients by helping them understand their condition and how their treatments work • Ensure that health professionals understand the dose ranges and relative potencies of inhaled corticosteroids • Undertake an audit of very high SABA use in patients with asthma and review those flagged as very high users
• Improve asthma control in patients on low dose of ICS as maintenance therapy	• In adults (aged ≥17), offer a LTRA in addition to low dose ICS as maintenance therapy and review in 4 to 8 weeks • In children and young people (aged 5 to 16) on a paediatric low dose of ICS as maintenance therapy, consider an LTRA in addition to the ICS and review the response to treatment in 4 to 8 weeks
• Improve COPD control and reduce use of SABA reliever inhalers	• Smoking cessation, exercise promotion and pulmonary rehabilitation, flu immunisation, and regular long acting bronchodilators
• Use combination inhalers for patient convenience and to support treatment adherence	• Change patients on more than one type of single inhalers (ICS, LABA, LAMA), where clinically suitable, to combination inhalers
• Promote effective self-management	• Written personal action plans
• Ensure all inhalers are used with correct technique for greater effectiveness	• Know how to teach this and do it • Encourage use of online video tutorials (https://www.prescqipp.info/our-resources/webkits/respiratory-care/inhaler-technique-assessment-videos/)
• Make optimal use of spacers to increase clinical effectiveness of pMDIs where these are clinically appropriate	• Consider using spacers for patients with pMDIs to aid inhalation: increases lung deposition and reduces oral deposition of drug • Encourage use of online video tutorials. (https://www.prescqipp.info/our-resources/webkits/respiratory-care/spacer-device-instruction-videos-and-leaflets/)
• Ensure patients have a pMDI and spacer emergency treatment pack for self-management of exacerbations, especially if using DPIs for regular treatment	• Provide emergency treatment packs with clear simple pictorial instructions for their use

1.1 Improve inhaler technique

Improving patients' inhaler technique would support optimising prescribing as poor inhaler technique can worsen an individual's control over their asthma.[27] Checking inhaler technique is included as one of the clinical responsibilities of Pharmacy Technicians set out in Annex B of the Network Contract DES Specification 2020/21, Additional Roles Reimbursement Scheme – minimal role requirements.[10]

The NICE Inhalers for asthma patient decision aid contains links to videos which demonstrate inhaler technique for a variety of inhalers. The aid also helps with inhaler choice based on the ability of the patient to use specific breathing techniques required for different inhalers.[3]

The PrescQIPP inhaler technique videos and leaflets can also be used to explain and demonstrate inhaler technique. These resources are not condition specific and so can be shown to anyone needing to use an inhaler. The videos and leaflets may be loaded onto organisational or GP practice websites and can incorporate NHS branding.

1.2 Reduce SABA overuse

Poor asthma control is associated with excessive prescribing of SABA inhalers which are said to be responsible for 9.24 million prescriptions and 250,000 tonnes of CO_2e annually, similar to driving an average diesel car for about 900 million miles. The SABA use IN Asthma (SABINA) programme found that 50% of UK asthma patients were potentially overusing SABA inhalers, with an average of 6.51 SABA inhaler prescriptions per year. SABA overuse was defined as the sum of prescribing ≥3 SABA prescriptions in 12 months versus 0 to 2. SABA overuse was associated with increased risk of exacerbation and asthma-related healthcare utilisation. SABINA I found that in the UK, 83% of SABA inhaler prescriptions for asthma went to patients overusing SABA. SABINA I also showed that SABA inhaler use drives 70% of carbon emissions from inhalers in the UK. The use of SABA inhalers per capita in the UK was approximately three or more times the figures seen in other large European countries. Prescription or collection of three or more SABA inhalers per year was associated with poor asthma control, approximately twice the number of exacerbations compared with low SABA users, and increased asthma-related healthcare utilisation. The SABINA I findings should be considered when producing asthma guidelines and healthcare policies to support improvements in asthma care and for achieving inhaler carbon emission savings.[29,30]

The IIF RESP-02 indicator has a target for the percentage of patients on the QOF Asthma Register who received six or more SABA inhaler prescriptions over the previous 12 months (range 15% to 25%). The IIF will reward PCNs for reductions in avoidable SABA prescribing.[11]

To support this target, the PrescQIPP EMIS and SystmOne GP clinical system searches, ' Very High SABA use in asthma', help to identify patients prescribed six or more SABA prescriptions in the last six months for patients on the GP practice asthma register. They can be found under 'Audit tools' in the Asthma focus resources.

1.3 Use combination inhalers

Where patients are using more than one inhaler from different therapeutic groups, these may be available as single combination inhalers. Switching patients using more than one single or dual component inhaler to a single combination inhaler, where one is available and is clinically suitable for the individual, will reduce the overall number of inhaler items used, be more convenient for patients and may improve adherence.

For example, a patient on single LAMA and LABA inhalers is changed to a LAMA/LABA combination inhaler; a patient on single ICS and LABA inhalers is changed to an ICS/LABA combination inhaler; a patient on an ICS/LABA combination and LAMA inhaler is changed to a ICS/LABA/LAMA combination inhaler (also known as multiple inhaler triple therapy).

Many combination inhalers are also often less expensive than prescribing inhalers individually. Attachment 1 (inhaler carbon emissions data) may be used to calculate the costs of using a combination inhaler in place of multiple single inhalers. The impact on the indicative inhaler carbon footprint may also be seen using attachment 1.

As combination inhalers are fixed dose, they may reduce the flexibility of dosing should patients require more frequent dose adjustments. This shouldn't present issues in patients on stable doses.

A maintenance and reliever therapy (MART) regime is a form of combined ICS and LABA treatment where a single inhaler contains both ICS and fast-acting LABA. MART is used for both daily maintenance therapy and the relief of symptoms as required.[12] So using a single inhaler in a MART regime may contribute to lowering the inhaler carbon footprint.

2. Substituting high carbon products for low-carbon alternatives

When patients need a review of their therapy, for example, when they present with uncontrolled symptoms, then this is an opportunity to consider, through shared decision making with the patient, switching to lower carbon footprint inhaler alternatives. Alternatively, during the patients annual review of their asthma or COPD, the healthcare professional or patient may raise the issue of using a lower carbon footprint inhaler alternative. Any inhaler switches need to be tailored to the individual. Switching to a different type of inhaler can be complicated for people with asthma, as it involves learning a new inhaler technique, so it should only be done with support from a healthcare professional.[31]

Where a new device is used, inhaler technique should be instructed and checked upon commencement. PrescQIPP inhaler technique videos and leaflets can be used to support this.

The IIF ES-01 has a target for pMDI prescriptions as a percentage of all non-salbutamol inhaler prescriptions issued to patients aged 12 years or over on or after 1 October 2021 (range: 35% to 44%). This aims to reward increased prescribing of DPIs and SMIs where clinically appropriate with a target of 25% of non-salbutamol inhalers prescribed will be pMDIs by 2023/24. The IIF ES-02 indicators has a target for the mean carbon emissions per salbutamol inhaler prescribed on or after 1 October 2021 (kg CO2e, range 15.5 kg to 19.4 kg per salbutamol inhaler prescribed). This aims to reduce the mean propellant carbon intensity of salbutamol inhalers prescribed in England to 11.1 kg per salbutamol inhaler prescribed by 2023/24.[11] The carbon footprint values for the salbutamol inhalers available are given in attachment 1. This indicator could be achieved by switching from a higher carbon salbutamol inhaler to a lower carbon salbutamol inhaler. The PrescQIPP data tool allows organisations to view the impact on carbon footprint and cost of any switches being considered. Tables 4 and 5 on pages 18 to 20 include examples of salbutamol inhaler switches which would also support this. The salbutamol inhaler will need to be prescribed by brand name rather than generic name to ensure the specific brand of salbutamol inhaler is dispensed and the desired carbon footprint value assigned.

When considering a switch to alternatives, it is important to consider whether there are any differences in clinical effectiveness between the devices, any licensing differences, the benefits of lower carbon footprint inhaler alternatives, patients views on changing inhalers, how to decide which patients are suitable for DPIs or SMIs, the financial impact of switching, any local guidelines supporting switching appropriate patients, and for those patients who still require their pMDI, whether to wait for the new lower carbon footprint propellants to become available for their pMDI. These points are considered further below. Attachment 1 provides useful comparative information which may be used when considering switching inhalers.

2.1 Benefits of lower carbon inhalers (DPIs/SMIs)

The following benefits of DPIs/SMIs over pMDIs have been suggested:[24]

- DPIs/SMIs do not contain HFCs
- Lower carbon footprint compared to pMDIs

- Fewer errors in inhaler technique
- Potentially improves disease control

2.2 Are there differences in clinical effectiveness between pMDIs, DPIs and SMIs?

In adults, there are no differences in clinical effectiveness between pMDI plus spacer, DPIs or SMIs. When choosing an inhaler device, the most important factors are: can the patient use the device effectively, are they happy to do so, cost and environmental impact.[32]

One study looked at the clinical effectiveness and patient satisfaction among patients with asthma and COPD switching from pMDI to Easyhaler® DPI treatment in a real-life setting. Adult patients (>18 years) previously suboptimally controlled on therapy via pMDI inhalers and requiring treatment with ICS/LABA combination inhaler according to GINA or GOLD guidelines were switched to budesonide/formoterol Easyhaler® 160/4.5 mcg or 320/9.0 mcg per inhalation. Clinical effectiveness assessed by Asthma Control Test (ACT), and COPD assessment test (CAT), health-related quality of life (HRQoL) assessments, and patient satisfaction were performed at recruitment and at 12 weeks. 142 patients with asthma and 95 patients with COPD (78.2%, 56.8% female; mean age 51.0, 65.5 years; 14.0%, 45.0% current smokers; respectively) were included in the study. Significant improvements in disease control at 12 weeks after the switch to Easyhaler® was observed; patients having well controlled asthma based on ACT increased from 7.0% to 80.3%, and patients having a very high impact of COPD on daily life based on CAT decreased from 13.7% to 0.0% ($p<0.001$, for both). Significant increases in HRQoL were also observed at 12 weeks after the switch as measured by mini-Asthma Quality of Life Questionnaire (mAQLQ) or modified Medical Research Council dyspnoea scale (mMRC) ($p<0.001$, for both). Almost all of the physicians (98.7%) regarded integration of Easyhaler® to the patients' daily life as very well or well accomplished, and 89.8% considered the use of Easyhaler® very easy or easy to teach. pMDI was rated as a very good inhaler by only 13.4% of the patients at baseline visit, whereas after the 12 weeks of use of Easyhaler® device 74.4% of the patients rated Easyhaler® as a very good inhaler. The authors concluded that a switch from pMDI to budesonide/formoterol Easyhaler® therapy showed significant clinical and quality of life improvements in patients with asthma and COPD. Patients' overall satisfaction was significantly higher with Easyhaler® than pMDI.[33]

The Salford lung study (SLS, sponsored by GSK), was a randomised controlled trial that compared a single combined DPI, fluticasone furoate/vilanterol (FF/VI) with usual asthma care over 12 months. Prior to randomisation, 70% of patients used pMDI maintenance therapy. Sustainable quality improvement (SusQI) methodology and NHS Sustainable development data were used to calculate the carbon footprint of the two treatment arms. The carbon footprint of healthcare visits and hospital stays were also calculated. Patients randomised to FF/VI had improvements in clinical outcomes and significant savings in their carbon footprint (141 kg CO_2e per patient per year) compared to usual care. The majority of the carbon footprint savings (129 kg CO_2e) came from switching the pMDI to DPI for maintenance treatment. The carbon footprint of salbutamol inhalers was slightly lower in the treatment arm (137 kg CO_2e) vs. 156 kg CO_2e). Usual care and FF/VI had little difference in carbon footprint of healthcare visits, 73 kg and 79 kg CO_2e respectively.[34]

2.3 Preventing treatment failures when switching to DPIs

An analysis was undertaken to assess the potential impact of an environmentally driven transition from pMDIs to DPIs on disease control in asthma and COPD. A model was developed to quantify the relationship between inhaler failure rates and exacerbations and associated hospitalisations. For the model, scenario analyses were developed using exacerbation rates from NICE economic models. For asthma, these were rates for treated and untreated asthma, as proxies for compliance and non-compliance respectively. For COPD, compliant population exacerbation rates were obtained from the NICE COPD guidelines supporting materials. The relative risk used in the NICE asthma model was applied to this value to estimate the non-compliance exacerbation rate. Estimates were provided per

1 million population using prevalence data from English General Practice. The modelling found that a modest shift to DPIs could lead to significant number of avoidable exacerbations and hospitalisations. It was estimated that for every 20% of the patient population experiencing treatment failure there would be an additional 4,100 and 5,223 exacerbations of COPD and asthma respectively per million population. Associated hospitalisation rates were estimated to be 287 and 141 for COPD and asthma respectively. The authors suggest that as there is evidence that face to face inhaler technique counselling can reduce treatment failure rates, with a repeat instruction after a period of time being the most effective intervention. So, a robust clinical management strategy will be required to support the transition to DPIs and minimise (or possibly reduce) exacerbation rates; this is likely to have significant resource implications and opportunity costs.[35]

2.4 What are patients views on changing inhalers?

In a small inpatient study in 20 patients prescribed both a pMDI and DPI, 80% said they were willing to change to a lower carbon footprint inhaler. All patients would change for increased effectiveness and 80% would be willing to change inhaler for one that is easier to use.[36]

Using a patient centred approach to inhaler prescribing that takes into account patients' preferences is important. Some patients will choose to use or remain on a pMDI but there is evidence that for some patients a DPI will be preferable. Device options should be discussed with patients and clinicians should feel confident to start a DPI or switch a pMDI inhaler to a DPI when clinically appropriate if patients are in agreement. Appropriate advice as well as regular inhaler technique reviews should also be offered.[37]

2.5 How to decide which patients are suitable for DPIs

NICE has produced a flowchart on how to use the inhalers describing the specific breathing technique required for each inhaler which health professionals may use with patients to help them understand the different techniques. For patients with asthma it is suggested that a DPI device is a suitable option for asthma patients who can breathe in through their mouth quickly and deeply over 2 to 3 seconds.[3]

DPIs are not an appropriate choice of inhaler for patients who are not able to generate sufficient inspiratory flow. Some examples of patients who might not be able to generate sufficient inspiratory flow include: frail, elderly patients, selected patients with COPD, very young patients or those with muscle weakness.[37] Consider inspiratory flow in this group of patients when considering a switch to a DPI.

2.6 Financial impact of switching device

Wilkinson and colleagues modelled how prescription costs and total carbon footprint in England would change by switching to lower carbon inhaler alternatives within therapeutic groups including SABAs, LABAs, ICS, LABA/ICS combinations and LABA/LAMA/ICS combinations using 2017 prescription data.

In their first model, pMDIs were replaced with DPIs in the same proportions that brands of DPIs were prescribed (proportional replacement), e.g. Three DPIs (A,B,C) are prescribed in 50%, 30% and 20% of occasions. In the model, 50% of pMDIs would be switched to DPI A, 30% to DPI B and 20% to DPI C. They found that for every 10% of pMDIs changed the total cost increased by £12.7 million annually.

In their second model, pMDIs were replaced with the cheapest available equivalent DPI within each therapeutic group. Overall, for every 10% of pMDIs changed in model 2, total costs decreased by £8.2 million annually. However, there were increased and decreased costs in some individual therapeutic switch groups.

The total carbon footprint of pMDIs prescribed in the community in England in 2017 was estimated to be 635 kt CO_2e. It was estimated that 58 kt CO_2e could be saved annually by switching 10% of pMDIs to lower carbon footprint inhaler alternatives. They concluded that prescribers switching from high carbon footprint inhalers to the least expensive lower carbon alternative in each therapeutic group could make large carbon reductions with financial savings. They also recommend smaller volume HFA-134a inhalers should be prioritised over larger volume HFA-134a inhalers or HFA-227ea containing inhalers and

publicising and encouraging inhaler recycling. They acknowledged that their analysis did not take into account newer products and only allowed comparison between treatments at a specific time.[24]

The PrescQIPP inhaler carbon footprint data tool allows users to view the impact of any inhaler switches they are considering in terms of inhaler carbon footprint and costs. Inhaler carbon footprint data in the tool comes from inhaler carbon footprint values contained in attachment 1.

2.7 Guidelines supporting switching appropriate patients

Clinical guidelines may increase awareness of the carbon footprint of different inhaler types and potentially alter prescribing decisions. It has been suggested that guidelines should be updated to highlight that DPIs are the preferred inhaler type when both pMDI and DPI are appropriate for the patient. They should also include the potential benefits of advising DPIs as the device of choice in new diagnoses of asthma and COPD as well as the benefits of switching patients currently using pMDIs to DPIs where clinically appropriate.[37]

2.8 Plan to switch patients who still require a pMDI to new lower carbon footprint pMDIs

It is recognised that some patients will need to remain on a pMDI for clinical reasons.[11] For those who remain on a pMDI for clinical reasons, the strategy could be to switch them to a lower carbon alternative pMDI. Some examples of switches to lower carbon salbutamol pMDIs are included tables 4 and 5 on pages 18 to 20.

Attachment 1 may also be used to identify suitable alternatives. The alternative lower carbon pMDI will need to be prescribed by brand name rather than generic name to ensure the specific brand of pMDI, which has a lower carbon footprint, is dispensed.

A lower carbon impact propellant, HFA-152a, is in development, but it is unlikely to be commercially available until the end of 2025.[8]

A cradle-to-grave Life Cycle Analysis (LCA) has shown that the carbon footprint of a HFA-152a pMDI reduced by over 90% compared to an equivalent HFA-134a pMDI.[38]

Switching from HFA-134a and HFA-227ea propellant pMDIs to HFA-152a pMDIs would significantly reduce the climate change impact by 90-92%.[39]

Another lower GWP propellant, HFO-1234ze(E), is in development with product launches possible in a similar timeframe to HFA-152a.[40]

The manufacturers survey responses highlighted that for 23 out of the 60 pMDIs (38%), manufacturers had plans to, or were actively considering, using a lower carbon footprint propellant.

For those who remain on a pMDI for clinical reasons, and no suitable alternative lower carbon inhaler is currently available, the strategy could be to wait for the introduction of these new lower GWP propellants.

3. Improvements in production and waste processes

3.1 Inhaler recycling or environmentally friendly disposal

In a study of 261 inhaler users over six months attending a secondary care respiratory clinic, just over half the patients (57%) were not aware that their inhaler could be recycled, and put them in the bin. Only 35% of patients recycled their inhalers through the appropriate scheme. A small number (8%) put their inhalers in the kerbside recycling bin, so had attempted to recycle them but were unaware that these went to landfill. All patients said they would recycle their inhalers in the future. The authors suggest the following to increase inhaler recycling:

- Inhaler recycling should be discussed routinely, ideally as part of inhaler technique checks, to increase knowledge around recycling facilities.

- Pharmaceutical companies should encourage recycling on inhaler packaging.
- Pharmacies should support inhaler recycling.[41]

The NICE inhalers for asthma patient decision aid also encourages patients to return any used pMDIs to a pharmacy for recycling or to be disposed of in an environmentally safe way as used pMDIs still contain propellants.[3] Patients are referred to the Government supported and funded Recycle Now website for more information on the safe recycling of inhalers: https://www.recyclenow.com/what-to-do-with/inhalers-0. The Recycle Now website states that all used inhalers should be returned to a pharmacy to be disposed of safely. It also says that landfill disposal of inhalers is harmful to the environment both in material waste and in greenhouse gas emissions from the residual gas remaining in inhaler canisters which are released into the atmosphere. If every inhaler user in the UK returned all their inhalers for one year, this could save 512,330 tonnes of CO_2e – the same as a VW Golf car being driven around the world 88,606 times.[14] The Recycle Now website contains links to the recycling information for Wales, Scotland, and Northern Ireland.

The International Pharmaceutical Aerosol Consortium (IPAC) is a consortium of pharmaceutical companies (AstraZeneca, Boehringer Ingleheim, Chiesi Farmaceutici, GSK, Kindeva, Organon and Teva) which has developed a programme to encourage patients to return their inhaler devices to pharmacies for green disposal. Inhaler Return Campaign materials are available on their website: https://www.ipacinhaler.org.[42]

3.2 Prevent over-ordering

Organisations should encourage patients to reduce inhaler waste by not over-ordering their inhalers and also by looking after their inhalers. The PrescQIPP prevent medicine waste campaigns - inhalers resources may be used to reinforce these messages. Patient information materials include 'How to manage your inhaler stock at home' and 'You don't have to order your inhalers every month' leaflets. A receptionist guide on 'How to manage inhaler supplies' is also available.

3.3 Increase use of re-usable inhalers

The budget impact of adopting the use of re-usable Respimat® inhalers in Germany was analysed. The optimal prescribing pattern which saved the most number of inhalers annually (eight inhalers) was four triple packs with one re-usable inhaler per year. By introducing re-usable inhalers in Germany, it was estimated that by 2023 the number of inhalers used would have decreased by 5,748,750 compared to not using re-usable inhalers. At the same time this would reduce the carbon footprint and costs. The authors concluded that adopting Respimat® re-usable inhalers to the national healthcare services may be a cost-saving option, which has the additional benefit of reducing the societal cost of carbon emissions.[43] The Respimat® triple pack refill cartridges are not currently available in the UK, but single refill cartridges containing 30 doses are available.[15]

Table 3 provides some practical examples of how to reduce the environmental impact of inhalers.

Table 3: Reducing the environmental impact of inhalers in respiratory care[3,27,41,43]

What to do	How to do it
• Ensure pMDIs are not discarded before they are empty	• Teach patients how to recognise correctly when inhalers are empty • Encourage wider use of dose counters on pMDIs

What to do	How to do it
• Promote inhaler recycling	• Encourage local pharmacies to take part in any local inhaler recycling schemes or develop and promote use of inhaler recycling schemes to reduce waste of plastic, metal and propellant • Educate patients about inhaler recycling and disposal as part of their inhaler technique check • Run patient education campaigns on reducing medicine waste for inhalers
• Optimise the use of re-usable inhalers	• Aim to prescribe refill cartridges with re-usable inhalers when prescribing Respimat inhalers

Prescribing data, costs and savings

The PrescQIPP inhaler carbon footprint data tool and visual data pack allows users to view their local prescribing data and how this compares to the national average. The impact of any switches to lower carbon footprint inhaler alternatives being considered, in terms of indicative carbon footprint and cost impact, can be reviewed. This supports decision making on strategies to reduce the inhaler carbon footprint.

Table 4 on page 18 provides examples of less complex inhaler switches which do not involve a change of drug to reduce the use of pMDIs. Table 5 on pages 19 to 20 provides examples of more clinically complex switches where more close monitoring is needed for the change or where there is an associated cost pressure. These reviews are more likely to take place during annual reviews. For both tables, the switches are given for some of the most frequently used pMDIs. The tables list whether the switch would involve a change in drug, device, licensed indication or age range. The cost and carbon footprint impact of the switch per inhaler are also given. The PrescQIPP data tool incorporates these switches so that the impact of these may be reviewed at a local level. The inhaler switch tool which is incorporated into the data tool may be used to manually check for alternatives and also view the cost and carbon impact of any switch. Organisations should consider prioritising cost saving and cost neutral switches initially.

These resources may be useful for organisations working towards the IIF four indicators focussed on improving inhaler prescribing to support improved respiratory outcomes and health outcomes for patients with asthma, and on delivering reductions in inhaler carbon emissions.[11]

For example, across England and Wales, **switching 25% of Ventolin pMDIs to Salamol pMDI would produce a 12 months carbon footprint saving of 106,699,451 kg CO_2e and produce a 12 months cost saving of £261,647. [NHSBSA Jun-Apr21]**

Switching 25% of Fostair® 100/6 pMDI to Fostair® NEXThaler 100/6 would be cost neutral and produce a 12 months carbon footprint saving of 14,442,353 kg CO_2e across England and Wales. [NHSBSA Jun-Apr21]

When considering any switch, these should be tailored to the individual through shared decision making with the patient as alternatives may not be therapeutically equivalent, inhaler device instruction will be needed and doses may need to be adjusted according to patient response after the switch. Also, consider any local guidelines supporting switching appropriate patients.

The RightBreathe website contains inhaler images and may be used in conjunctions with tables 4 to 5 when developing lowering the inhaler carbon footprint strategies or discussing lower carbon footprint inhaler options with patients.

Table 4: Examples of less complex inhaler switches to reduce the use of pMDIs

Switch from pMDI	Switch to lower carbon footprint alternative	Therapeutic group[15]	Different drug(s)?[15]	Different device?[15]	Cost impact per inhaler[25,46]	Indicative carbon footprint reduction per inhaler (g CO_2e)[24,47]	Difference in licensed indication or age range?[17,44-45]
Switches with a cost saving							
Ventolin Evohaler® 100 micrograms	Salamol 100 micrograms pMDI	SABA	No	No	-£0.04	-16,312	No
Atimos Modulite 12 micrograms/ dose inhaler	Formoterol Easyhaler® 12 micrograms DPI	LABA	No	Yes	-£6.31	-12,456	Atimos Modulite is age 12+, Formoterol Easyhaler® is age 6+.
Seretide 250 Evohaler®	Stalpex 50/500 micrograms DPI	ICS/LABA	No	Yes	-£4.76	-18,360	Seretide 250 Evohaler licensed for asthma only. Stalpex 50/500 DPI licensed for asthma and COPD
Seretide 250 Evohaler®	Fixkoh Airmaster 50/500 micrograms DPI	ICS/LABA	No	Yes	-£5.20	-18,360	Seretide 250 Evohaler licensed for asthma only. Fixkoh Airmaster 50/500 is licensed for asthma and COPD
Seretide 250 Evohaler®	Fusacomb Easyhaler® 50/500	ICS/LABA	No	Yes	-£2.33	-18,913	Seretide 250 Evohaler licensed for asthma only. Fusacomb Easyhaler® 50/500 licensed for asthma and COPD.
Cost neutral switches							
Fostair® 100/6 pMDI	Fostair® NEXThaler 100/6	ICS/LABA	No	Yes	£0.00	-10,359	No
Fostair® 200/6 pMDI	Fostair® NEXThaler 200/6	ICS/LABA	No	Yes	£0.00	-13,263	No

Table 5: Examples of clinically complex inhaler switches or associated with a cost pressure to reduce the use of pMDIs

Switch from pMDI	Switch to lower carbon footprint alternative	Therapeutic group[15]	Different drug(s)?[15]	Different device?[15]	Cost impact per inhaler[25,46]	Indicative carbon footprint reduction per inhaler (g CO_2e)[24,47]	Difference in licensed indication or age range?[17,44-46]
Switches with a cost saving							
Serevent 25 micrograms Evohaler®	Formoterol Easyhaler® 12 micrograms DPI	LABA	Yes	Yes	-£5.51	-18,679	Serevent Evohaler age is 4+, Formoterol Easyhaler® is age 6+
Qvar® 100 inhaler	Easyhaler® Beclometasone 200 micrograms	ICS	No	Yes	-£2.28	-19,740	Qvar for age 5+, Easyhaler® Beclometasone age 18+.
Flutiform® 250/10 micrograms pMDI	Fusacomb Easyhaler® 50/500	ICS/LABA	Yes	Yes	-£18.57	-35,928	Flutiform 250/10 licensed for asthma only. Fusacomb Easyhaler® 50/500 licensed for asthma and COPD.
Flutiform® 125/5 micrograms pMDI	Fusacomb Easyhaler® 50/250	ICS/LABA	Yes	Yes	-£6.50	-35,928	
Switches with a cost pressure							
Clenil® Modulite 100 micrograms/ dose	Easyhaler® Budesonide 100 micrograms	ICS	Yes	Yes	+£1.44	-15,902	No lower age limit stated for Clenil® Modulite in SPC, BNF states use from 2+. Easyhaler® Budesonide is age 6+.
Clenil® Modulite 200 micrograms/ dose	Easyhaler® Budesonide 200 micrograms	ICS	Yes	Yes	+£1.54	-15,672	Clenil® Modulite 200micrograms is adults only. Easyhaler® Budesonide age 6+.

Switch from pMDI	Switch to lower carbon footprint alternative	Therapeutic group[15]	Different drug(s)?[15]	Different device?[15]	Cost impact per inhaler[25,46]	Indicative carbon footprint reduction per inhaler (g CO_2e)[24,47]	Difference in licensed indication or age range?[17,44-46]
Switches with a cost pressure							
Clenil® Modulite 250 micrograms/ dose	Easyhaler® Budesonide 400 micrograms	ICS	Yes	Yes	+£1.42	-15,767	Clenil® Modulite 250micrograms is adults only. Easyhaler® Budesonide age 6+.
Seretide 125 Evohaler®	Seretide 250 Accuhaler®	ICS/LABA	No	Yes	+£10.50	-18,587	No
Ventolin Evohaler® 100 micrograms	Airomir 100 micrograms pMDI	SABA	No	No	+£0.47	-18,542	No
Ventolin Evohaler® 100 micrograms	Easyhaler® Salbutamol 100 or 200 micrograms DPI	SABA	No	Yes	+£1.81 or +£5.13	-27,642	No
Ventolin Evohaler® 100 micrograms	Salbulin Novolizer® 100 micrograms DPI	SABA	No	Yes	+£3.45	-24,512	Ventolin is age 4+, Salbulin Novolizer is age 6+.
Ventolin Evohaler® 100 micrograms	Ventolin Accuhaler® 200 micrograms	SABA	No	Yes	+£2.10	-27,679	No
Other switches							
Separate ICS, LABA and LAMA inhalers	Use combination inhalers	ICS/LABA or ICS/LABA/ LAMA	Depends on starting inhalers	Depends on starting inhalers	Cost saving potential Reduces number of pMDIs used	Depends on starting inhalers	Depends on starting inhalers

Summary

The NHS has committed to reducing the carbon footprint of health and social care in line with the Climate Change Act target of 51% by 2025. This target includes reducing the carbon emissions from inhalers. A range of strategies can support achievement of this target including optimising prescribing, switching to lower carbon footprint alternatives where clinically appropriate, reducing inhaler waste and environmentally safe inhaler disposal. Organisations should agree strategies for lowering the local inhaler carbon footprint through a relevant group such as the local Area Prescribing Committee, involving all key stakeholders and communicating any changes to them.

References

1. Lavorini F, Corrigan CJ, Barnes PJ, et al. Retail sales of inhalation devices in European countries: So much for a global policy. Respir Med 2011;105(7):1099-103. https://www.resmedjournal.com/article/S0954-6111(11)00100-4/fulltext
2. NHS Executive. Phase out of CFC containing metered dose inhalers for the treatment of asthma and COPD. Health Service Circular (HSC 1998/18). 23 October 1998. https://webarchive.nationalarchives.gov.uk/ukgwa/20120503111041/http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Healthservicecirculars/DH_4004810
3. NICE. Inhalers for asthma (patient decision aid). Published 23 May 2019. Last updated 01 Sept 2020. https://www.nice.org.uk/guidance/ng80/resources
4. NHS England and NHS Improvement. Delivering a 'Net Zero' National Health Service. Published October 2020. https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2020/10/delivering-a-net-zero-national-health-service.pdf
5. Myrdal PB, Sheth P, Stein SW. Advances in metered dose inhaler technology: formulation development. AAPS PharmSciTech 2014;15(2):434-55. https://europepmc.org/article/MED/24452499
6. NICE. Inhalers for asthma (patient decision aid user guide). 23 May 2019. https://www.nice.org.uk/guidance/ng80/resources
7. Pritchard J.N. The environmental impact of MDI propellants - What now? Journal of Aerosol Medicine and Pulmonary Drug Delivery 2020;33(2):A-2. https://www.liebertpub.com/doi/pdf/10.1089/jamp.2020.ab01.abstracts
8. Chiesi Group. Press release. Chiesi outline €350 million investment and announces first carbon minimal pressurised Metered Dose Inhaler (pMDI) for Asthma and COPD. 04/12/2019. https://www.chiesi.com/en/chiesi-outlines-350-million-investment-and-announces-first-carbon-minimal-pressurised-metered-dose-inhaler-pmdi-for-asthma-and-copd/
9. NHS England. The NHS Long Term Plan. January 2019. https://www.longtermplan.nhs.uk/wp-content/uploads/2019/08/nhs-long-term-plan-version-1.2.pdf
10. NHS England and NHS Improvement. Network Contract Directed Enhanced Service Contract specification 2020/21 – PCN Requirements and Entitlements. 17 September 2020. https://www.england.nhs.uk/publication/network-contract-des-specification-2021-22/
11. NHS England and NHS Improvement. Primary Care Networks – plans for 2021/22 and 2022/23. Annex B – Investment and Impact Fund: 2021/22 and 2022/23. https://www.england.nhs.uk/wp-content/uploads/2021/08/B0828-iii-annex-b-investment-and-impact-fund-21-22-22-23.pdf
12. SIGN/BTS. British guideline on the management of asthma (SIGN 158). First published 2003, revised edition published July 2019. https://www.brit-thoracic.org.uk/quality-improvement/guidelines/asthma/

13. NICE. NICE encourages use of greener asthma inhalers. 8 April 2019. https://www.nice.org.uk/news/article/nice-encourages-use-of-greener-asthma-inhalers#_edn2
14. Waste and Resources Action Programme. Recycle Now. What to do with inhalers. https://www.recyclenow.com/what-to-do-with/inhalers-0 accessed 27/06/21.
15. Joint Formulary Committee. British National Formulary (online) London: BMJ Group and Pharmaceutical Press. https://www.medicinescomplete.com/ accessed 17/09/21.
16. MIMS online. Twickenham: Haymarket Media Group http://www.mims.co.uk/ accessed 27/06/21.
17. Electronic Medicines Compendium (emc). Summaries of Product Characteristics. https://www.medicines.org.uk/emc/ accessed 17/09/21.
18. Association of British Pharmaceutical Industry (ABPI) and the Carbon Trust. Blister Pack Carbon Evaluation Tool. https://www.abpi.org.uk/medicine-discovery/building-a-thriving-environment-for-medicine-discovery/how-do-we-monitor-and-regulate-medicines/sustainability/ accessed 17/06/21.
19. Panigone S, Sandri F, Ferri R, et al. Environmental impact of inhalers for respiratory diseases: decreasing the carbon footprint while preserving patient-tailored treatment. BMJ Open Resp Res 2020;7:e000571. doi:10.1136/bmjresp-2020-000571
20. Hänsel M, Bambach T, Wachtel H. Reduced Environmental Impact of the Reusable Respimat Soft Mist™ Inhaler Compared with Pressurised Metered-Dose Inhalers. Advances in Therapy 2019;36(9):2487-2492 https://link.springer.com/content/pdf/10.1007/s12325-019-01028-y.pdf
21. Borenius K, Vartiainen V, Takala A, et al. P185 Life cycle assessment and cradle-to-grave carbon footprint of a multidose reservoir dry powder inhaler Thorax 2021;76:A189-A190. https://thorax.bmj.com/content/76/Suppl_1/A189.2
22. Borenius K, Vartiainen V, Takala A, et al. Life Cycle Assessment (LCA) and Cradle-to-Grave (CTG) Carbon Footprint of a Multidose Reservoir Dry Powder Inhaler. European Respiratory Journal 2020;56(suppl 64):3183 (conference abstract) https://erj.ersjournals.com/content/56/suppl_64/3183
23. Janson C, Henderson R, Lofdahl M, et al. Carbon footprint impact of the choice of inhalers for asthma and COPD. Thorax 2020;75(1):82-84. https://thorax.bmj.com/content/thoraxjnl/75/1/82.full.pdf
24. Wilkinson AJK, Braggins R, Steinbach I, et al. Costs of switching to low global warming potential inhalers. An economic and carbon footprint analysis of NHS prescription data in England. BMJ Open 2019;9:e028763. doi:10.1136/bmjopen-2018-028763
25. NHSBSA. dm+d browser. https://services.nhsbsa.nhs.uk/dmd-browser/ accessed 17/09/21.
26. International Organisation for Standardisation (ISO). ISO 14067:20189(en). Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification. https://www.iso.org/obp/ui/#iso:std:iso:14067:ed-1:v1:en accessed 18/08/21.
27. Keeley D, Scullion JE, Usmani OS. Minimising the environmental impact of inhaled therapies: problems with policy on low carbon inhalers. Eur Respir J 2020;55:2000048 https://erj.ersjournals.com/content/erj/55/2/2000048.full.pdf
28. NICE. Asthma: diagnosis, monitoring and chronic asthma management [NG80]. 29 November 2017. www.nice.org.uk/guidance/ng80
29. Harman C. Overuse of asthma reliever inhalers 'a major contributor' to CO_2 emissions in respiratory care. MIMS 17 February 2021. https://www.mims.co.uk/overuse-asthma-reliever-inhalers-a-major-contributor-co2-emissions-respiratory-care/respiratory-system/article/1707676
30. Wilkinson A, Menzies-Gow A, Sawyer M, et al. S26 An assessment of short-acting β2-agonist (SABA) use and subsequent greenhouse gas (GHG) emissions in five European countries and the consequence of their potential overuse for asthma in the UK. Thorax 2021;76:A19. (conference abstract) https://thorax.bmj.com/content/thoraxjnl/76/Suppl_1/A19.1.full.pdf
31. Asthma UK. Sustainable inhaler switch must not be at expense of people with asthma staying well. https://www.asthma.org.uk/about/media/news/sustainable-inhaler-switch-must-not-be-at-expense-of-people-with-asthma-staying-well/ accessed 26/05/21.

32. Connelly D. Blue, brown and now green. The Pharmaceutical Journal;304(7938). DOI:10.1211/PJ.2020.20208093
33. Galffy G, Szilasi M, Tamasi L. P227 Clinical effectiveness, health-related quality of life and patient satisfaction after switch from metered dose inhaler to Easyhaler® dry powder inhaler in patients with asthma and COPD; a real-life study. Thorax 2019;74(suppl 2):A212-3 https://thorax.bmj.com/content/thoraxjnl/74/Suppl_2/A212.2.full.pdf
34. Hunt FJN, Wilkinson A. P186 Carbon footprint analysis of the salford lung study (asthma): A SusQI analysis. Thorax 2021;76:A190. https://thorax.bmj.com/content/76/Suppl_1/A190.1
35. Jenkins D, Johal J, Mahon J. P228 Analysis of the potential clinical impact of an environmentally driven transition from pressurised metered dose inhalers (pMDIs) to dry powder inhalers (DPIs). Thorax 2019;74:A213-A214. https://thorax.bmj.com/content/74/Suppl_2/A213
36. Walpole SC, Fitzpatric A, Moffatt K, et al. P187 Ease of use, effectiveness and environmental impacts: Evaluating inhaler prescriptions, patient preferences and opportunities for improvement. Thorax 2021;76:A190-A191. https://thorax.bmj.com/content/thoraxjnl/76/Suppl_1/A190.2.full.pdf
37. Starup-Hansen J, Dunne H, Sadler J, et al. Climate change in healthcare: Exploring the potential role of inhaler prescribing. Pharmacol Res Perspect 2020;e00675. https://doi.org/10.1002/prp2.675
38. Corr S. Development of HFA-152A as a sustainable PMDI propellant. Journal of Aerosol Medicine and Pulmonary Drug Delivery 2020;33(2):A-28. https://www.liebertpub.com/doi/pdf/10.1089/jamp.2020.ab01.abstracts
39. Jeswani HK, Azapagic A. Life cycle environmental impacts of inhalers. Journal of Cleaner Production 2019;237:117733 https://www.sciencedirect.com/science/article/pii/S0959652619325934
40. Pritchard JN. The Climate is Changing for Metered-Dose Inhalers and Action is Needed. Drug Design, Development and Therapy 2020;14:3043-3055. https://europepmc.org/backend/ptpmcrender.fcgi?accid=PMC7410333&blobtype=pdf
41. De Vos R, Rupani H, Longstaff J, et al. Inhaler recycling prevalence in a secondary care clinic in England. European Respiratory Journal 2020;56:1886. https://erj.ersjournals.com/content/56/suppl_64/1886
42. The International Pharmaceutical Aerosol Consortium (IPAC) Inhaler Return Campaign. https://www.ipacinhaler.org/resource-hub accessed 17/09/21.
43. Ortsäter G, Borgström F, Baldwin M, et al. Incorporating the Environmental Impact into a Budget Impact Analysis: The Example of Adopting RESPIMAT Re-usable Inhaler. Applied Health Economics and Health Policy 2020;18:433–442. https://link.springer.com/content/pdf/10.1007/s40258-019-00540-0.pdf
44. European Medicines Agency. European Public Assessment Report. https://www.ema.europa.eu/en/glossary/european-public-assessment-report last accessed 26/06/21.
45. MHRA. Products. Summary of Product Characteristics (SPCs) and Patient Information Leaflets (PILs). https://products.mhra.gov.uk/ last accessed 26/06/21.
46. C+D Data. Available at www.cddata.co.uk last accessed 17/09/21.
47. Manufacturers responses to PrescQIPP survey 'Inhaler carbon footprint'. Data on file and included in Attachment 1. Inhaler carbon emissions data. Last updated August 2021.

Additional PrescQIPP resources

Briefing	https://www.prescqipp.info/our-resources/bulletins/bulletin-295-lowering-the-inhaler-carbon-footprint/
Implementation tools	
Data pack	https://data.prescqipp.info/?pdata.u/#/views/B295_Inhalercarbon-footprint/FrontPage?:iid=1

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