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PRACTICE POINTER

Towards net zero: asthma care

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What you need to know

- Hydrofluorocarbon propellants used in pressurised metered dose inhalers (pMDIs) disproportionately contribute to healthcare's environmental impact
- Reduced use of pMDIs improves planetary outcomes as well as clinical outcomes for patients
- Whenever clinically appropriate, consider low carbon inhalers (dry powder or soft mist) rather than high carbon pMDIs
- Seek opportunities to review asthma care at every consultation

Asthma affects over 260 million people and causes more than 460 000 premature deaths annually worldwide.[1] There is variation in asthma care and its carbon footprint globally: the UK, for example, has a high hospital admission rate and mortality for asthma compared with other high income countries,[1 2] and it has a high carbon footprint from inhalers. At the centre of these two problems is an over-reliance on pressurised metered dose inhalers (pMDIs)—short acting β agonist (SABA) reliever pMDIs in particular[3] but also inhaled corticosteroid preventer pMDIs.[4 5] There is no clinical rationale for this inter-country variation, and we, therefore, use the UK as an example of a country where there are many opportunities for change. The principles that we present apply globally.

What is the problem?

Widespread use of inhalers with high carbon footprints

The National Health Service (NHS) in England is the only healthcare system in which emissions have been comprehensively calculated, and in this system 13% of the emissions under its direct control (excluding supply chain emissions) are due to inhalers used to treat asthma and other airways diseases.[6] This equates to 3% of the total NHS carbon footprint.

SABA inhalers contribute 67% of England's inhaler carbon footprint,[7] and 70% of all inhalers issued in England are pMDIs, (a higher proportion than in many other countries in Europe, such as only 13% of inhalers used in Sweden being pMDIs).[8] Within England, variation with the proportion of corticosteroid preventer inhalers that are pMDIs has also been demonstrated; this ranges from 37% in North Tyneside to 70% in North East Lincolnshire.[9]

High SABA use is also associated with poor clinical outcomes, as shown in a confidential inquiry investigating deaths from asthma or anaphylaxis in the four UK nations between February 2012 and January 2013.[2] This confirms that there are two strong incentives for changing asthma care practice: to reduce morbidity and mortality and to reduce the impact of asthma care on the environment.

Following a move away from chlorofluorocarbon (CFC) propellants, as part of the global commitment laid out in the 1989 Montreal Protocol on Substances that Deplete the Ozone Layer,[10] pMDIs now contain hydrofluorocarbons (HFCs). These are over 1000 times more potent as greenhouse gases than carbon dioxide (CO_2).[8 11] Although the 2019 Kigali Amendment added HFCs to the Montreal Protocol,[12] exemptions are in place for medical uses such as inhalers. Dry powder inhalers (DPIs) and soft mist inhalers (SMIs) have substantially lower carbon footprints than pMDIs as they do not contain HFCs.[8 11] Although there is no standardised method for measuring the carbon footprint of inhalers, best estimates support a broad categorisation based on HFC propellant gas into low (inhalers that do not use HFC gases), moderate (inhalers that use the HFC named HFA134a), and high carbon inhalers (inhalers that use the HFC named HFA227ea) (see table 1).[11]

Table 1 | Carbon footprint by inhaler type (according to PresQIPP inhaler carbon footprint comparison tool[11])

Inhaler type	Indicative annual carbon footprint	
	Carbon dioxide equivalent (kg CO2e)	Equivalent km driven in a mid-size petrol car
All dry powder inhalers and soft mist inhalers	1-24	5-130
Pressurised metered dose inhalers (pMDIs):		
Containing HFA134a (most pMDIs)	7-240	38-1209
Containing HFA 227ea (Flutiform and Symbicort MDI*)	429-835	2323-4521

* Only Symbicort MDI contains HFA227ea. Symbicort Turbohaler is a dry powder inhaler.

Overdiagnosis and underdiagnosis of asthma

Asthma is both underdiagnosed and overdiagnosed—patients are commonly given a SABA inhaler for breathlessness or wheeze without diagnostic pulmonary function tests (peak flow diary, spirometry with reversibility, bronchial provocation test, or exhaled nitric oxide).[13] A study of NHS prescription data from England in 2017 found that up to 30% of patients in England with a diagnostic label of asthma did not have the disease.[14] These and other patients may be using SABA inhalers without clinical benefit, with a high environmental cost.

Underdiagnosis also exists and increases the risks of daily symptoms, exacerbations, and airway remodelling. Questionnaires and objective testing of 10 000 randomly selected people aged 14-44 years in Copenhagen identified 493 with "definite asthma"; of these, 50% had not been diagnosed previously.[15] Survey data from 192 young adults entering US military service who had respiratory symptoms on exercise, suggested that, of those diagnosed with asthma at enrolment (using spirometry in all and bronchial provocation testing in 67%), a diagnosis of asthma had never been previously considered in 30%.[16]

Lack of regulation and incentives that support appropriate inhaler use, reuse, and disposal

Many inhalers do not have dose counters, which means there is a risk of patients throwing away partly used inhalers prematurely.[17] Most inhalers are disposed of in domestic waste and, because of the lack of large scale recycling schemes globally, end up in landfill where their HFCs are leaked into the atmosphere. Additionally, very few inhalers are reusable or refillable. The Respimat (tiotropium bromide) SMI has a reusable dispenser, and refills are available[18]; however, the entire inhaler is often re-prescribed rather than the just the refill cartridge on its own.

Factors such as plastic and metal pollution also contribute to environmental damage; but carbon footprint is the best described environmental impact of inhalers.[19]

What are the solutions?

Look for opportunities to optimise clinical care

- Ensure diagnoses are correct (see box 1). Global Initiative for Asthma (GINA) and National Institute for Health and Care Excellence (NICE) guidelines recommend offering spirometry with reversibility, peak flow diary monitoring, and fractional exhaled nitric oxide (FeNO), where available, to both newly diagnosed patients and existing patients who are taking SABA alone. Bronchial provocation testing is recommended when there remains diagnostic doubt. However, we acknowledge that, in areas with limited healthcare infrastructure and resource, making an accurate diagnosis can be more challenging if availability of spirometry and peak flow testing are limited.[20]

  While we advocate for objective pulmonary function testing, we advise that, when clinicians are confident about a diagnosis of asthma, patients can be treated with inhaled corticosteroid or corticosteroid plus long acting β agonist (LABA) while waiting for objective pulmonary function testing; and that a peak flow diary and/or eosinophilia on full blood count can be considered as adequate confirmation if objective pulmonary function testing is not available.

- If asthma is confirmed, use shared decision making to create a self management plan, and transition to a corticosteroid or corticosteroid-LABA inhaler as the primary medication, as per guidelines from GINA.[21]

- Identify patients who are issued more than three SABA inhalers a year and

  - Optimise their treatment in line with GINA and British Thoracic Society guidelines, ensuring they are receiving the right drug, device, and dose to control disease
  - Optimise inhaler technique—in person ideally or via video, supported by specialist nurses or pharmacists—and increase use of maintenance and reliever treatment (MART) and anti-inflammatory reliever (AIR) regimens with the aim of eliminating SABA use in appropriate patients (see box 2).[22 23] Additional training may be required so all professionals can reliably assess and teach inhaler technique.[24 25]

Box 1: Hypothetical case where asthma diagnosis is incorrect

- *Clinical scenario*—An adult patient has clinical features that are not suggestive of asthma and has perceived no benefit from pMDI medications. Pulmonary function testing revealed no reversibility and low FeNO. Breathing pattern disorder was diagnosed, and pMDI medications weaned over time, then stopped completely. FeNO was rechecked and remained low.
- *Previous medication regimen*—Clenil modulate (beclomethasone dipropionate) pMDI 200 µg 2 puffs twice daily, and Salamol (salbutamol) pMDI 100 µg 1-2 puffs as required (patient was using this twice daily).
- *New medication regimen*—Alternative management strategies for breathing pattern disorder employed.
- *Estimated carbon savings per year*—83 kg CO_2e (equivalent to ~418 km driven (London to Newcastle upon Tyne (UK) or Central Park New York to The White House, Washington (USA) in a petrol car.

pMDI = pressurised metered dose inhaler, FeNO = fractional exhaled nitric oxide, CO_2e = carbon dioxide equivalent.

Box 2: Hypothetical case where MART therapy has clinical and environmental benefits

- *Clinical scenario*—On annual review, an adult patient is found to be over-relying on SABA and to be able to use the technique appropriate for DPI (that is, able to take a quick deep breath). The patient was offered MART therapy.
- *Previous medication regimen*—Symbicort (budesonide/formoterol) pMDI 100/6 1 puff twice daily and Ventolin (salbutamol) pMDI 1 puff as required.
- *New medication regimen*—Symbicort Turbohaler (budesonide/formoterol) 100/6 1 puff twice daily maintenance and 1 puff as required.
- *Estimated carbon savings per year*—220 kg CO_2e (equivalent to ~1100 km (Aberdeen to Penzance) driven in a petrol car).

MART = maintenance and reliever treatment, SABA = short acting β agonist, DPI = dry powder inhaler, pMDI = pressurised metered dose inhaler, CO_2e = carbon dioxide equivalent.

These measures will reduce the carbon footprint of asthma care even before any changes to inhaler device are considered.

- Other opportunities to optimise treatment, as outlined above, include when patients present with exacerbations, repeat prescription requests, and during routine asthma reviews.
- Within shared decision making conversations, discuss non-pharmacological factors such as allergen and air pollution

exposure, physical activity, immunisation, and psychosocial factors.

- If patients have exacerbations despite optimised treatment, consider assessment for biologic therapies such as omalizumab, mepolizumab, and reslizumab where available.[26]

Consider prescribing lower carbon inhalers

- Encourage practitioner behaviour change to favour DPIs (and SMIs) over pMDIs.[19 27] A post hoc analysis of 2236 patients in England showed reduced asthma symptoms and greater productivity in daily activities in patients switching from pMDI to DPI.[27]
- Assess for suitability to use DPIs. DPIs require a deep, quick inhalation and may not be suitable for all patients. Young children and frail older adults, in particular, may not have the technique or inspiratory capacity to achieve this (consider objective testing with a peak flow measuring device if there is doubt). In one UK asthma service, 93.7% of adult patients achieved necessary peak inspiratory flow for high resistance DPIs.[28] A review of studies across Europe, Japan, Argentina, and the US that included children as young as 3 years old concluded that the evidence supports the efficacy of DPI in treating asthma and COPD irrespective of patient age, even during acute exacerbations.[29] There is international variation in the age deemed suitable for DPI use: for example, in the UK this is age 12 years, whereas in Finland children as young as 6 years are recommended DPIs.[30]
- When choosing inhalers, make shared decisions with patients after discussing the patient's ability to use the device effectively, preference, their ability to maintain effective inhaler technique and the environmental impact. This is reflected in a NICE decision aid on asthma inhalers and climate change.[31] Avoid blanket switches (where patients are not involved in the decision, merely informed of the switch), which include a change of device or active ingredient, as these can be unsafe and disempowering for patients.
- In a survey of 12 145 UK asthma patients, although 65% were unaware of the carbon footprint of pMDIs, 60% of pMDI users would consider changing device for environmental reasons and 85% thought asthma patients should be encouraged to use more environmentally friendly inhalers.[32] However, always discuss environmental impact collaboratively and sensitively. It is important that patients do not stop their treatment due to concerns about its environmental impact. It is the responsibility of healthcare systems, not individuals, to reduce the environmental impact of care. Be warned that concern about clinical risks from changes in practice that are not evidence based can lead to inaction and persisting poor clinical and environmental outcomes.[1 33]
- Consider cost as part of a wider shared decision making process, as it might be a barrier to change, although many inhaler switches are at least cost-neutral. If a switch to a DPI is more expensive, consider the full cost of care[14] because, if control is improved with increased use of inhaled corticosteroid, then any increased cost may be offset by the reduced need for multiple SABAs and by reduced exacerbations. Nevertheless, in some countries, including where patients directly purchase their medications, the cost of DPIs can be a barrier.[34]

Consider opportunities to reduce the carbon footprint of asthma care even for those remaining on pMDIs

- Prescribe fewer puffs of a higher strength inhaler as this reduces the amount of propellant used (see box 3).
- Prescribe a SABA pMDI with a lower carbon footprint: one which uses a low volume of propellant (such as Salamol or Airomir) in place of inhalers that use a high volume of propellant (such as Ventolin).
- Avoid the highest carbon footprint inhalers (those containing propellant HFA227ae, see table 1) unless no alternative exists.
- Prioritise non-pharmacological interventions such as allergen and air pollution avoidance, physical activity, and immunisation.
- Reduce the frequency of automatic repeat prescriptions for SABA inhalers, or change prescriptions to be available only on request.
- Encourage patients to use every dose in their inhalers (facilitated by dose counters on inhalers).

Box 3: Hypothetical case where environmental impact is reduced for a patient who requires pMDI

- *Clinical scenario*—An adult patient with no recent exacerbations and who is open to change in order to reduce the environmental impact of their asthma care is found to be able to use pMDI most effectively.
- *Previous medication regimen*—Qvar (beclomethasone diproprionate) pMDI 50 µg 2 puffs twice a day and Ventolin (salbutamol) pMDI 100 µg 1 puff as required.
- *New medication regime*—Qvar (beclomethasone diproprionate) pMDI 100 µg 1 puff twice daily and Airomir (salbutamol) pMDI 100 µg 1 puff as required.
- *Estimated carbon savings per year*—404 kg CO_2e (equivalent to ~2035 km (Oxford, UK, to Rome, Italy) driven in a petrol car).

pMDI = pressurised metered dose inhaler, CO_2e = carbon dioxide equivalent.

Campaign for system changes, innovation of inhaler design, and implementation of recycling schemes

- Engage national and regional leaders to drive change as international policy alone is unlikely to deliver the urgent change required.[10 12 35]
- Implement schemes for recycling or incineration of all inhalers to ensure any remaining HFC is salvaged or destroyed. In England, community pharmacies are required to advise patients to return inhalers to pharmacies for disposal (currently, incineration as not yet linked to recycling).[36] A pilot postal scheme in Leicestershire, England had 20 049 inhalers returned and recycled over 12 months, saving an estimated 119.3 tonnes of CO_2e.[37]
- Actively amplify the voice of clinicians and patients—pharmaceutical companies have an opportunity to innovate device design to reduce environmental impact but are unlikely to do so without this demand. Pharma-led solutions could include: use of lower GHG HFC propellants in pMDIs, such as HFA 152a[38] and HFO-1234ze[39] which are in development; reducing plastic use (for all inhalers) to protect ocean health; and the adoption of circular economy principles in which waste and pollution are designed out of inhaler devices and materials can be recycled and reused.[40]

Place a greater focus on asthma prevention

- Collaborate with patients to advocate for policies and interventions to prevent asthma by reducing indoor and outdoor air pollution, strengthening tobacco control policies, improving housing, and addressing all causes of health inequalities.
- Work to match resource allocation, particularly in terms of quality improvement project support, staff time, and research funding, with the urgency of the need for change.

Global efforts to reach net zero for asthma care

- To reach net zero, low cost, low carbon inhalers will need to be made available in all countries. The WHO includes budesonide and budesonide-formoterol in the list of essential medicines for asthma. There are ongoing efforts to make such medications available in functioning health systems at all times, in appropriate dosage forms, of assured quality, and at prices individuals and health systems can afford.[41]
- A retrospective analysis of data from hospitalizations in the Brazilian public health system of individuals with asthma aged from 1 to 49 years, showed that, since the provision of free access to beclomethasone and salbutamol inhalers in 2011, there has been a reduction in hospitalisations for asthma.[42]
- Inhaled corticosteroid is under-prescribed and underused in India, contributing to an estimated 42% of global asthma deaths.[43] An editorial in *Lung India* suggests that, if corticosteroid or corticosteroid-formoterol inhalers were to come under the Drug Price Control Order Act in India, access to them would improve.[44 45]
- Both NHS England[6] and Scotland[46] have committed to net zero by 2040 for the emissions they control. Unfortunately, NHS England recently removed financial incentives that rewarded general practitioners for prescribing lower carbon inhalers.[47]
- National and local prescribing guidelines are an opportunity to address climate change in clinical practice. National guidance in Finland,[30] New Zealand,[48] and the UK specifically recommend taking into account the carbon footprint of inhalers when prescribing for asthma. In Finland, dry powder inhalers are recommended as the primary form of administration for most school age children and adults.

Information resources for clinicians and patients

Clinicians

- Greener Practice. High quality and low carbon asthma care (https://www.greenerpractice.co.uk/high-quality-and-low-carbon-asthma-care/)
- ERS. Environment and health (https://www.ersnet.org/advocacy/environment-and-health/)
- PrescQIPP. Bulletin 295: Inhaler carbon footprint (https://www.prescqipp.info/our-resources/bulletins/bulletin-295-inhaler-carbon-footprint/)
- Centre for Sustainable Healthcare. Sustainable respiratory care network (https://networks.sustainablehealthcare.org.uk/network/sustainable-respiratory-care)

Patients

- Asthma and Lung UK (https://www.asthma.org.uk/)
- NICE. NG80 Asthma inhalers and the environment patient decision aid: Asthma inhalers and climate change (https://www.nice.org.uk/guidance/ng80/resources/inhalers-for-asthma-patient-decision-aid-pdf-6727144573)
- Green Inhaler (https://greeninhaler.org/)
- European Lung Foundation. Healthy lungs for life (https://european-lung.org/en/projects-and-campaigns/healthy-lungs-for-life/)

Education into practice

- What dosing regimens and lower carbon footprint options could you offer to asthma patients who continue to need pressurised metered dose inhalers?
- How do you create asthma care plans that optimally manage symptoms with a reduced need for short acting β agonist inhalers?
- What could your practice do to campaign for changes to prevent asthma?

How patients were involved in the creation of this article

A patient with asthma is a co-author on this article. They agreed the outline on the article, and suggested a greater emphasis on practical steps, and the importance of shared decision making. They reviewed the initial draft and made multiple changes to structure and content, in particular suggesting emphasising the value of specialist nurses and pharmacists, as well as changes to language around patient empowerment. They reviewed all suggested resources to ensure they were appropriate and valuable from a patient perspective.

In addition, as a result of an external patient review, arranged by the BMJ we made it clearer that there are multiple ways to reduce environmental impact, including options for different global settings. We also explicitly stated that patients should not stop their inhalers and emphasised that poorly controlled asthma carries the greatest environment burden. We highlighted more strongly that it is the responsibility of the system not the individual to reduce the environmental impact of care.

How this article was created

To write this clinical update we started with the personal archives of references on asthma care and environmental impact of James Smith and LJ Smith. We supplemented this with a Medline search using terms (environmental OR carbon OR net zero) AND inhaler. NICE, BTS, SIGN, and GINA guidelines were searched for reference to environmental impact. The Cochrane Database was searched for reference to inhalers. International guidelines were sought by searching respiratory society websites.

Contributors: JS had the initial idea for the article and its core themes. All authors met to discuss and agree key messages and article sections and provided initial references. JS wrote a first draft on the basis of these discussions and all authors commented, substantially altering the text before initial submission. LJS conducted a Medline search. LJS led on responding to reviewer's comments. All authors commented on subsequent reviews. RB provided calculations of carbon footprint that were independantly calculated by JS and LJS. RK made material changes to language and emphasis, foregrounding the patient voice. All authors reviewed the final manuscript.

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Patient consent: Not required (cases are hypothetical).

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