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CTS GUIDELINES AND POSITION PAPERS

Canadian Thoracic Society Position Statement on Climate Change and Choice of Inhalers for Patients with Respiratory Disease

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KEY MESSAGES

- Inhalers contribute to climate change, with metered dose inhalers (MDIs) currently accounting for the greatest greenhouse gas emissions among all inhalers.
- Shared decision making with patients, incorporating inhaler indication, effectiveness, technique, patient preference, patient capability, cost and side-effects, as well as the environmental impact of different inhaler delivery systems is the preferred approach when choosing an inhaler with a patient.
- A multi-layered approach involving clinicians, patients, health system organizations, regulators and manufacturers is needed to reduce the impact of inhalers on the environment.

Background

Human-induced climate change is the greatest health threat of the twenty-first century.[1] As the climate crisis deepens, patients who experience respiratory illness are at particular risk of poor health,[2] including through heat waves and particulate air pollution,[3,4] which increase symptoms, exacerbations and healthcare utilization in both asthma and chronic obstructive pulmonary disease (COPD).[5,6]

In Canada, healthcare accounts for 4.6% of the national greenhouse gas (GHG) emissions,[7] including those directly from healthcare facilities and their supply chains.[8] Most health system emissions arise from pharmaceutical and medical equipment manufacturing, as well as care delivery.[9] An example of the latter is the pressurized MDI, which currently relies on hydrofluorocarbon (HFC) propellants, which are potent GHGs. In contrast, dry powder inhalers (DPIs) and soft mist inhalers (SMIs) have an overall carbon footprint that is about 10 times lower than that of MDIs.[10] Although Canadian market data are not publicly available, in the United Kingdom, asthma MDIs comprise 94% of short-acting beta-agonists (SABAs),[11] 56% of inhaled corticosteroids (ICS)[12] and 47% of ICS-long-acting beta agonists (LABAs).[11] In general, MDIs contribute a majority of emissions during their use (56–70%) and disposal (26–32%) while DPIs contribute 50–90% of emissions during production and 0–20% during use and disposal.[11] While MDIs' contribution to overall societal GHG emissions is modest, MDIs alone contribute 3.1% of emissions in the United Kingdom's National Health Service.[13] Accordingly, DPIs and newer MDIs using non-HFC propellants present unique opportunities for reductions in health system GHG emissions.[14]

As the national inter-professional society on respiratory diseases and recognizing our role in addressing the lung health impacts of climate change, the Canadian Thoracic Society (CTS) believes that it is important for our organization to provide a summary of its position in this fast-evolving area. To this end, the Chair of the Canadian Respiratory Guidelines Committee (SGu) and members of the CTS Executive invited leaders and experts from across Canada to contribute to this statement. Recruitment considered gender, geographic diversity (across provinces) and career stage diversity. The audience for this position statement includes specialists (respirologists and internists), family physicians, pediatricians, allied health team members, decision makers and patients who use inhalers. Accordingly, the panel included: adult respirologists (SGu, SC, GD, CC, EP); a family physician and representative from the national "Creating a Sustainable Canadian Health System in a Climate Crisis" (CASCADES) initiative (SGr); a pediatric respirologist

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(SMT); a nurse and certified respiratory educator (JH); a nurse practitioner and representative from the Canadian Respiratory Health Professionals (CRHP) (RA); an expert in environmental and public health (CC); and a person living with asthma (JH). In addition, the CTS is an active participant in the Choosing Wisely Canada (CWC) initiative.[15,16] Given the alignment of this position statement with CWC's goal of reducing treatments that may contribute to the climate crisis, a corresponding CTS Choosing Wisely statement is published alongside this CTS position statement (see below), led by the CTS CW Working Group lead (GD).

As per CTS policies, the position statement was approved by the CTS Executive and will be updated as new information becomes available.

Approaches to reduce inhaler-related greenhouse gas emissions

Improving quality of care to reduce inhaler-related greenhouse gas emissions

Improved use of diagnostic testing

Due to infrequent use of objective testing for diagnosis, many patients carrying a label of airways disease have in fact been misdiagnosed.[17,18] For example, studies suggest that 31–44% of patients diagnosed with COPD in primary care do not actually have the disease.[19,20] Similarly, 33% of patients diagnosed with asthma by a physician in the last 5 years had no evidence of asthma on pulmonary function testing, yet 79% of these patients without asthma were using asthma medications.[21] Accordingly, efforts to improve objective diagnosis in airways disease may significantly reduce unnecessary inhaler use and corresponding GHG emissions.[22]

Improved adherence to guideline-directed care

More than half of patients with asthma and COPD have inadequate disease control due to suboptimal controller inhaler regimens,[23,24] resulting in excessive SABA reliever inhaler use.[25,26] Overuse of SABAs (>2 canisters per year) is a major contributor to inhaler GHGs, since SABAs are overwhelmingly prescribed as MDIs and this is a marker of poor control associated with exacerbations, which are high-carbon events. In one study, suboptimal asthma control was associated with triple the carbon emissions of well-controlled disease.[27] Here, efforts to improve adherence to guideline-based assessment of disease control and corresponding therapeutic escalation could significantly reduce the carbon footprint associated with both asthma and COPD,[12] both through reduction in rescue MDI use and by averting the need for exacerbation care.

Table 1. Overview of inhaler form, carbon footprint and considerations for inhaler choice.

Inhaler format	 SMI	 DPI[a]	 pMDI (current)	 pMDI (future)
Relative carbon footprint[b]	<1 (LOW)	1 (LOW)	15–30 (HIGH)	<1[c]–2[d] (LOW)
Requirements	• Age ≥ 4 • Teaching and demonstration required to minimize critical errors	• Age ≥ 4[e] • Adequate inspiratory flow rate/pressure • Teaching and demonstration required to minimize critical errors	• Any age • Spacer (or VHC/facemask in early life) • Teaching and demonstration required to minimize critical errors	• Any age • Spacer (or VHC/facemask in early life) • Teaching and demonstration required to minimize critical errors
Advantages	• Lack of propellent decreases carbon footprint • Propellant-free solution under mechanical pressure requires a low inspiratory flow rate/pressure • May be used with a spacer (or VHC/facemask in early life) • Amenable to caregiver administration • Often has a dose indicator	• Lack of propellent decreases carbon footprint • Often has a dose counter	• Often less expensive than DPI alternative • Amenable to caregiver administration	• Newer propellants have much lower to no GHGs emissions • Amenable to caregiver administration
Limitations	• Coordination may be difficult when no spacer used • Dose cannister must be loaded in device • Priming required	• Younger, older patients and some patients with acute / chronic respiratory disease may lack sufficient inspiratory flow rate/ pressure for adequate administration	• Propellent generally carbon-intensive • Dose counter not often available • Need to shake and prime	• Newer propellants with low to no GHG emissions not yet available for existing inhalers • Cost unknown

Abbreviations: DPI, dry powder inhaler; GHG, greenhouse gas; pMDI, pressurized multi-dose inhaler; SMI, soft-mist inhaler; VHC, valved holding chamber.
[a]Other DPI devices include: respiclick™, inhub™, genuair™, aerolizer™, handihaler™
[b]For specific inhaler carbon footprint estimations, see PrescQIPP resource: https://www.prescqipp.info/our-resources/bulletins/bulletin-295-inhaler-carbon-footprint/
[c]Relative estimate for HFO-1234ze molecule.[14]
[d]Relative estimate for HFA-152a molecule.[67]
[e]DPI devices are approved for children aged ≥ 4 years but preschool aged children may not be able to consistently achieve adequate pressures, nor form a tight seal around the mouthpiece of the device and require extensive teaching and verification.
Note. Inhaler images in Table 1 are from the Electronic Asthma Management System (eAMS), reproduced with permission from Dr. Samir Gupta.

Ensuring appropriate MDI technique

Studies show that inhalers are used incorrectly 12–71% of the time,[28–32] and this problem may be worse with MDIs than with DPIs.[33–36] Administration misuse with MDIs is particularly common in older adults (with 79% demonstrating critical errors) and in children (with 97% demonstrating misuse).[37,38] Inhaler misuse is associated with poor disease control (driving increased rescue MDI use), decreased quality of life, increased emergency department visits and hospitalizations (carbon-intensive events) and increased need for oral steroids and antimicrobials.[28,30,32,38] Ensuring proper inhaler technique by demonstrating and reviewing with patients in clinic and encouraging the use of a spacer when using an MDI can both lead to greater drug delivery, resulting in improved disease control, decreased SABA overuse, fewer exacerbation events and thus reduced GHG emissions.[32,39,40]

Achieving these improvements in care will require complex interventions, but will not only yield reduced carbon emissions, but also improved patient outcomes. Also of note, as newer propellants with much lower Global Warming Potential (GWP) than current HFCs are approaching market release,[14] the balance of the environmental harms between MDIs and DPIs will soon shift. Regardless, a focus on improving quality of diagnosis, disease control and technique will continue to reduce *overall* inhaler use and its environmental impacts.

Shared decision making and patient education

There are three direct actions that can reduce inhaler-related emissions: prescribing a DPI over an MDI for patients newly starting on therapy; changing patients already on an MDI to an equivalent DPI; and informing patients about appropriate disposal options. Corresponding approaches should always consider individual patients' needs and preferences through shared decision making.

Prioritizing DPIs over MDIs

First, when initiating a new controller or rescue medication, providers can prioritize DPIs over MDIs. Although >70% of inhalers sold constitute MDIs, in adults, corresponding DPIs show similar efficacy and are often preferred by patients.[41–44] Second, existing patients can often be switched from an MDI to a DPI, as many MDIs have DPI versions within the same drug class (and sometimes the same molecule). In one study, changing an MDI to a DPI halved the carbon footprint among people with asthma without significantly affecting their asthma control level.[45] In addition, certain class changes can reduce inhaler-related GHGs while remaining in concordance with guideline recommendations. For example, the CTS asthma guideline considers daily ICS therapy with a SABA reliever (both of which are most often delivered through MDIs but are also available as DPIs) to be equivalent to as-needed budesonide-formoterol (delivered through a DPI) in patients aged ≥12 years with well-controlled asthma and at a high risk of exacerbation.[46] When MDIs *are* needed, providers can select MDIs which use a lower GHG propellant (HFC-134a rather than HFC-227ea) and/or "low volume" HFCs, where a smaller metered valve is used, reducing emissions.[47] For example, a low-volume HFC salbutamol MDI (eg, Teva-Salbutamol or Airomir) contains the GHG equivalent of driving 39 km in a standard gasoline powered vehicle, compared to 113 km for a comparable high-volume agent.[47,48]

Patient considerations when selecting or changing inhaler devices

When either selecting a device for a new inhaler prescription or considering substituting an MDI with a DPI, several factors must be considered (Box 1) (Table 1). Some patients simply prefer MDIs,[49] device changes can reduce patients' confidence in their medication[50] and multiple changes to therapy are a strong predictor of non-adherence.[51] Non-adherence can lead to a loss of disease control, engendering both direct morbidity and mortality risks for patients, but also paradoxically increased GHG emissions through carbon-intensive events such as acute exacerbations.[52]

Box 1. Practical considerations when selecting an inhaler device.

- Patient preference
- Impact of inhaler device on adherence
- Inhalation technique (patient ability)
- Inspiratory flow rate/pressure required for adequate medication delivery (patient ability)
- Patient age
- Cost for patient and/or public healthcare system
- Side effect profile
- Environmental footprint

Some patients cannot supply the energy required to adequately dispense and disperse powder from a DPI. This may occur in severe lung disease (at baseline or due to an acute disease exacerbation)[53] but cannot be accurately predicted from spirometric data.[54,55] However, these concerns likely apply to only a small minority (<5%) of patients with chronic lung disease such as COPD.[53] Because maximal inspiratory pressures increase from birth to about age 25 and decrease thereafter, concerns about adequate medication delivery *via* DPIs also arise with advancing age and in children.[56,57] Although some DPI devices are approved for children aged ≥4 years, preschool aged children may not be able to consistently achieve adequate negative pressures, nor form a tight seal around the device mouthpiece. Accordingly, DPIs should generally be avoided in this age group.

Finally, although studies suggest that careful selection of the lowest cost DPIs within each drug class can reduce overall costs compared to MDIs,[47] cost implications may vary according to patients' insurance coverage and must be considered individually. At a system level, one study showed that substituting only 2–5% of MDIs with DPIs annually would result in GHG emission reductions of 38–58% over 50 years, with only slightly increased costs.[52]

Educating patients about disposal options

Inhaler disposal through incineration is another opportunity to reduce GHGs from MDIs. Incineration results in thermal degradation of HFC chemicals, resulting in lower GWP by-products. Recycling also has the potential to reduce GHG emissions through the recovery of the propellant during the disposal phase.[47] Although a national inhaler recycling policy is needed, some pharmacies accept inhaler returns and facilitate recycling and incineration (information available at: https://healthsteward.ca/), and patients should be educated to return their inhalers to pharmacies for proper disposal.[58]

Implementation strategies

Existing programs

CASCADES is a federally funded initiative that supports Canadian healthcare's transition toward a climate resilient, sustainable, and low carbon health system. CASCADES has partnered with both patients and clinical leaders (including the CTS) to develop resources to support providers in sustainable inhaler prescribing. Primary care resources include inhaler comparison charts with provincial coverage information, template letters to patients, posters, emergency medical responder (EMR) resources, and inhaler technique videos. Hospital-focused resources include process map templates, formulary and order set templates, and educational tools for hospital-based stakeholders. Materials are freely available online at: https://cascadescanada.ca/resources/all-topics/inhalers/.

Regulatory approaches

Although Canada was a forerunner in the ban of chlorofluorocarbons (CFC)-based propellants in 1998 (through the United Nations' Montreal Protocol), we have not yet seen regulatory action pertaining to HFCs in Canada. Under current legislation, HFC producers and importers are required to apply for authorization to use HFCs.[59] Although collective HFC allowances are progressively reduced according to a regulated schedule, HFCs in MDIs are exempt.[60] While similar legislation is in place in Europe, in April 2022, the European Commission proposed to no longer exempt HFCs in MDIs from these allowances.[61] In the United States, the Environmental Protection Agency's 2022 HFC allowance limits included limits for HFCs used in MDIs.[62]

Following suit, a coalition of Canadian scholars, and environment- and health-related organizations (including the CTS) have lobbied the Minister of Environment and Climate Change of Canada to remove high GWP HFC propellants from MDIs within the next five years, especially as much lower GWP HFCs will likely be commercially available by 2025. In addition, legislative requirements for manufacturers to review inhaler packaging (eg, decreasing plastic) and to implement national recycling schemes are required.

Opportunities for standardization of practices

Due to infection control concerns in the context of the pandemic, many hospitals permanently limited nebulizer use in favor of MDIs during brief admissions or emergency room visits by patients with respiratory disease. As these inhalers are single-patient use, this often results in disposal of MDIs still containing large amounts of propellant and resulting waste. Similar concerns exist in pulmonary function labs, where MDIs are administered for bronchodilator response tests. Standard policies for minimizing waste in these settings could assist local organizations to consider environmentally conscious practices while balancing infection control requirements.

Guidance from other organizations

In their latest asthma guideline, the British Thoracic Society (BTS) includes recommendations on the environmental impact of MDIs,[63] emphasizing that prescribers, pharmacists, and patients should be aware of the GWP of different devices and select inhalers with a lower GWP when they are likely to be equally effective.[63] The European Respiratory Society's position statement on asthma and the environment is more cautionary toward universal approaches to switch stable respiratory patients from an MDI to a DPI, emphasizing the need for a multi-faceted approach including diagnostic confirmation, patient and provider education, and inclusive shared decision-making with patients.[64] To this end, the National Institute for Health and Care Excellence (NICE),[65] in conjunction with BTS and Scottish Intercollegiate Guideline Network (SIGN),[63] developed a patient decision aid providing pros and cons of potential inhaler device changes, including environmental impacts. Notably, all three documents refer to the pressing need to develop inhaler recycling and disposal strategies.

Action by the Canadian Thoracic Society

In addition to this position statement, the CTS is active in raising awareness and in advocacy with decision makers. Future iterations of our asthma and COPD guidelines will include a section discussing inhaler environmental impacts. As noted, the CTS has also produced and will disseminate a Choosing Wisely Canada Recommendation addressing this issue (see associated publication). In addition, the CTS has partnered with the CASCADES initiative, adding content expertise to their diverse dissemination materials and co-developing implementation strategies. Finally, the CTS highlighted this important area through a keynote plenary session at our annual Canadian Respiratory Conference, in April 2023 (https://cts-sct.ca/crc/).

Conclusions

Climate change is a leading threat to the overall health of our planet, and directly affects the respiratory health of the population, particularly of those suffering from respiratory disease. The Intergovernmental Panel on Climate Change[66] has concluded that there is a rapidly closing window in which the world can limit global warming to the 1.5°C target, emission reductions are needed from all sectors, and every fraction of a degree of warming matters, as it impacts climate-related morbidity and

mortality.[67] As clinicians and the professional society charged with enhancing the prevention and treatment of respiratory diseases affecting Canadians, we have the knowledge and tools to make a positive impact on climate change through our actions. For individual providers, this includes efforts to implement existing and long-standing best practice guidelines for asthma and COPD care, as well as careful consideration of inhaler selection, with active patient engagement. The approaches described in this statement are achievable, but will require education for providers, patients and decision-makers alike, along with theory-driven implementation strategies and measurement of their effectiveness. At the same time, we believe that the individual incentive for climate action is in itself a powerful behavioral motivator that will spur action.

CTS Choosing Wisely statement on metered-dose inhalers

Choosing Wisely Canada (CWC) is the national voice for reducing unnecessary tests and treatments in Canada. Through recommendations developed by professional societies representing clinical specialties, CWC seeks to reduce unnecessary tests and treatments that expose patients to potential harm, consume precious health care resources and/or contribute to the climate crisis.

The impact of prescribed therapies on the environment is of particular importance in respiratory medicine given the intimate link between air quality and lung health. For this reason, to accompany the CTS Position Statement on Climate Change and Choice of Inhalers for Patients with Respiratory Disease, the CTS CWC Working Group developed a complementary CWC recommendation. This recommendation was developed collaboratively with the Position Statement authorship through review of the literature and discussion with CTS CWC Working Group members:

Don't prescribe greenhouse gas-intensive metered-dose inhalers (MDIs) for asthma and/or COPD where an alternative inhaler with a lower carbon footprint (e.g. dry power inhaler (DPI), soft-mist inhaler, or MDI with a low greenhouse gas potential propellant) containing medications with comparable efficacy is available, and where the patient has demonstrated adequate technique and patient preference has been considered.

MDIs contain HFC propellants, which contribute to global warming.[67,68] When prescribing inhalers, providers should consider whether an objective diagnosis of asthma and/or COPD exists or needs to be confirmed, in keeping with existing CWC CTS recommendations (#1 and #5).[69] Also, optimal choice of controller inhaler agents and non-pharmacologic strategies (eg, education, trigger avoidance, action plans) should always be included in airway disease management, as they not only improve patient outcomes, but can also reduce rescue inhaler use.

We acknowledge that low carbon footprint inhalers may not be appropriate for some patients. For example, preschool children and individuals with certain cognitive limitations may not be able to coordinate movements required for DPI inhalers.[25,70] Similarly, those with end-stage lung disease, muscle weakness, other physical limitations and/or medical frailty may not be able to generate the inspiratory force required to achieve adequate pulmonary drug delivery through a DPI device.[4,53] During emergencies, and in the emergency room setting, some people with asthma and/or COPD may also lack the inspiratory force to adequately use a DPI.[54] Other patients simply prefer MDIs.[49,64] Ultimately, whether starting or substituting an inhaler, providers must consider medication efficacy, patient preference, adherence, technique, cost and side-effect profile.[71] Ideally, a shared decision-making approach should be used, and the environmental benefits of alternatives to greenhouse gas-intensive MDIs should also inform this decision.

With the anticipated development of a growing number of MDIs which use newer propellants with a low greenhouse gas potential, the opportunity to select low carbon footprint inhalers will expand. Other factors which will remain important and require ongoing attention include GHGs released in the production of inhalers, after their use and in their disposal.

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Author contributions

S. Gupta conceived of the manuscript; all authors drafted the manuscript for important intellectual content; and S. Gupta and E. Penz revised and edited the manuscript for submission.

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